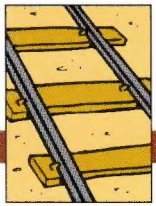
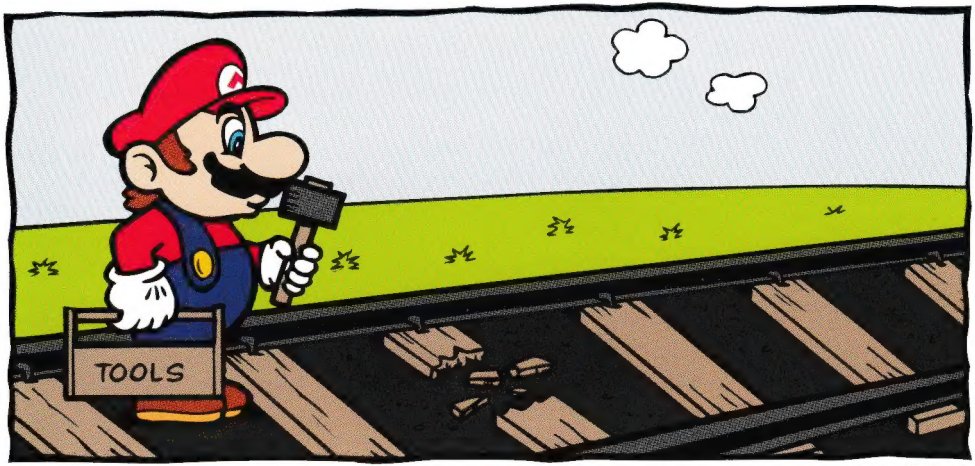
Which is used to make train tracks?



LAND TRANSPORTATION

1. Steel
2. Wood
3. Both wood and steel



©1995 Nintendo

Train Tracks

Railroad tracks consist of steel rails attached to wooden ties. The wooden ties stretch across a level roadbed of crushed stone.

3 Both wood and steel are used to make train tracks.

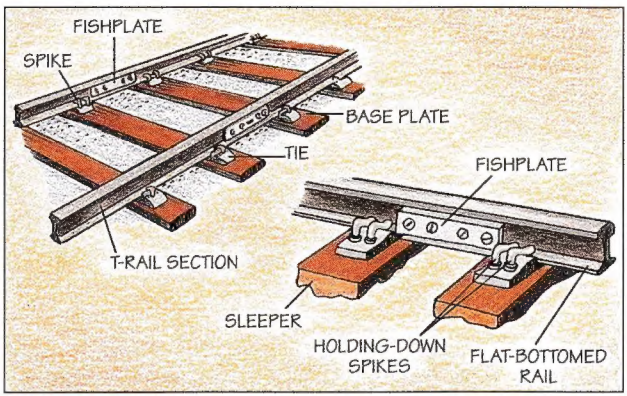


Illustration by Irene Miedzinski

The illustration shows how the train track is constructed. Ask a friend to name each train-track parts and tell what it is and what it's used for!

Where's the Wood?

Once a smooth, level, roadbed has been prepared for a train track, wooden ties or crossties are placed across it. An average of 3,000 ties per mile (1,800 per km) are used, so the wooden pieces are spaced approximately 21 inches (53 cm) apart. The ties will keep the rails an equal distance apart and hold the track together.

Set the Steel!

Two steel plates or tie plates are nailed to the top of each crosstie, near each end. The grooved plates hold the bottom of the rails. The steel rails, manufactured in 39 ft (12 m) and 78 ft (24 m) lengths, are joined together end-to-end by steel joint bars or fishplates. (The end of one rail and the beginning of the next may not be exactly level, so a train wheel makes a click-clack sound when passing over fishplates!) In fact it's advisable to leave a small gap between the end of one rail and the start of another to allow the metal to expand during very hot weather. Now we've got the track, all we need is a train!

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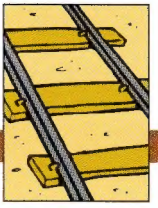
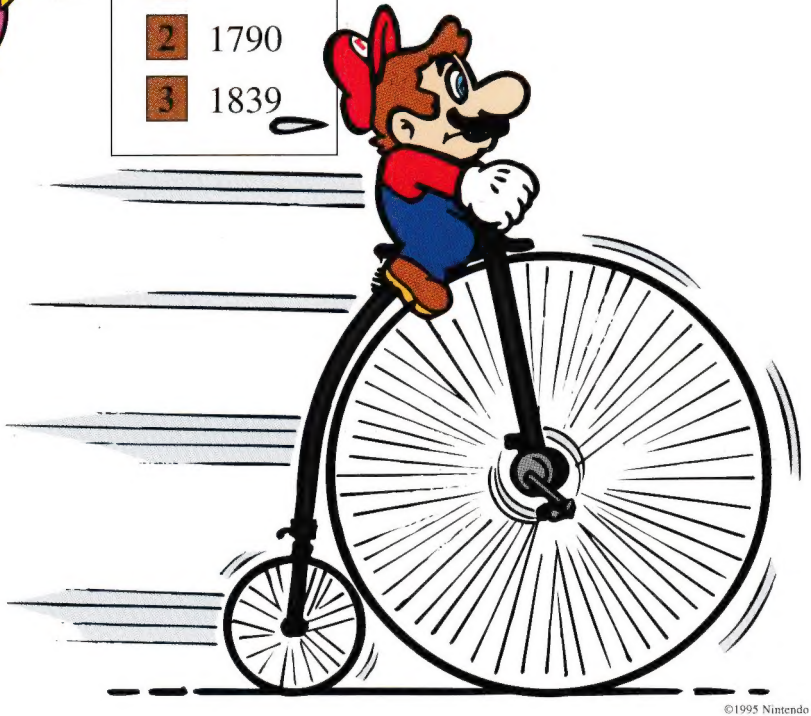
When was the first bicycle built?



LAND TRANSPORTATION

1. 1620
2. 1790
3. 1839

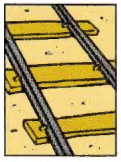


©1995 Nintendo

Bicycle

Some people think the bike was invented in 1790. But that was a two-wheeled push-bike that you walked like a hobby horse! The real bicycle didn't come along for almost 50 years.

3 The first true bicycle was built in 1839.



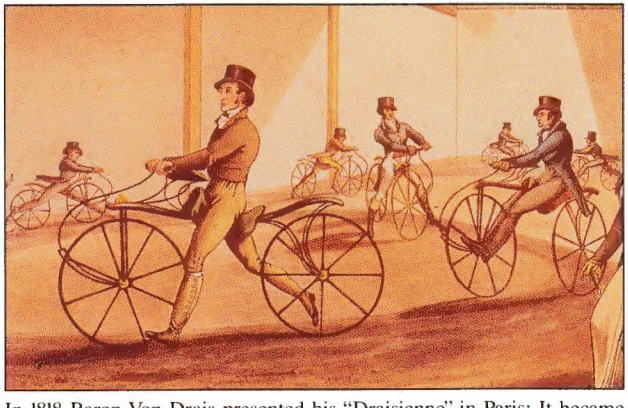


Photo © Explorer Archives

In 1818 Baron Von Drais presented his "Draisienne" in Paris: It became all the rage in London too.

In 1790, France's Count de Sivrac built a wooden frame on two iron wheels. To make this "thing" go, you pushed your feet alternately on the ground—like that broomstick you pretended was a horse! Then in 1817, Germany's Baron Von Drais added a saddle, a steering handlebar, and iron-trimmed wood wheels to a pushbike.

Pedal to the Metal

Scotland's Kirkpatrick Macmillan added a crank to the rear wheel in 1839, and for the first time, the two-wheeler was thought of as a true bicycle. It could go 14 miles (22.5 km) per hour! In 1861, Pierro Michaux added pedals. To round out the international story, the U.S. got into the game in 1878 when Colonel Albert Pope of Connecticut became the first American bicycle manufacturer. His model was called the "Columbia." In 1880, a Britisher named Starley made a bike with chains, and in 1887, Dunlop invented the inflatable tire.

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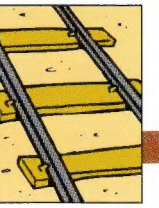
How does a bicycle pump work?



LAND TRANSPORTATION

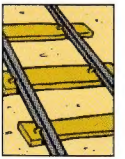
1. With gas pressure
2. With compressed air
3. With water pressure

©1995 Nintendo

Bike Tires

When air is squeezed into a small space, it exerts force as it tries to find an opening where it can escape. It's this compressed air that runs jackhammers and fills bike tires to make them strong enough to hold the weight of the bike and rider.

2 A bicycle pump fills a tire with compressed air.



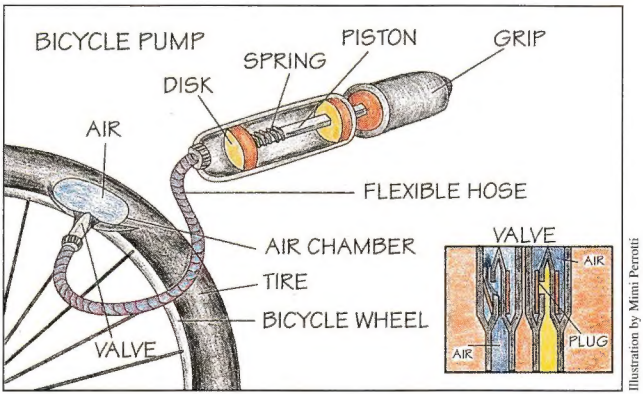


Illustration by Mimi Perrotti

Air pressure from the pump pushes the tire valve open to let the air enter. When the pump is removed, pressure from the air in the tire pushes back against the valve to close it.

When someone pulls up on the grip or handle of a bicycle pump, a disk inside is pulled to the top of a column of air inside the mechanism. Then, when the person pushes down the handle, the disc is forced toward the bottom of the pump, pressing down on the column of air. The air is compressed to its smallest volume. The air molecules speed up as pressure becomes much greater than normal.

The Great Escape

When the pump is attached to the valve on a tire, the built-up pressure of the air exerts force against it. As the air forces the valve open, it shoots with tremendous power into the tire itself. There the fast-moving molecules heat up and press against the walls of the tire to inflate it.

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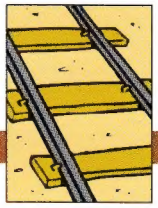
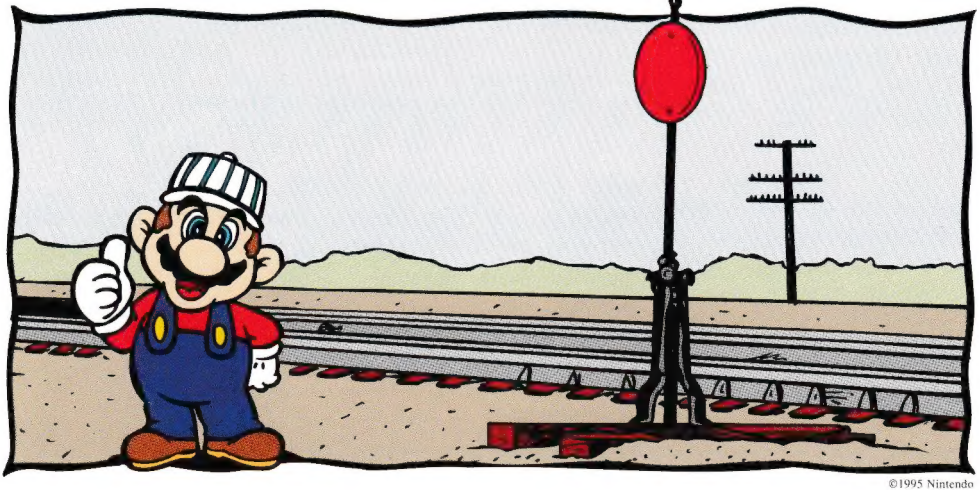
What allows a train to change direction?



LAND TRANSPORTATION

1. Ballast in the engine
2. Switches on the tracks
3. Temperature of the fuel



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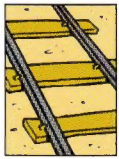
Switching

Switching, a system that uses moveable rails, permits a train to change direction. The switches roll the train wheels from one track onto another. Trains may switch rails many times during a long trip.

2 Switches on the tracks allow a train to change direction.



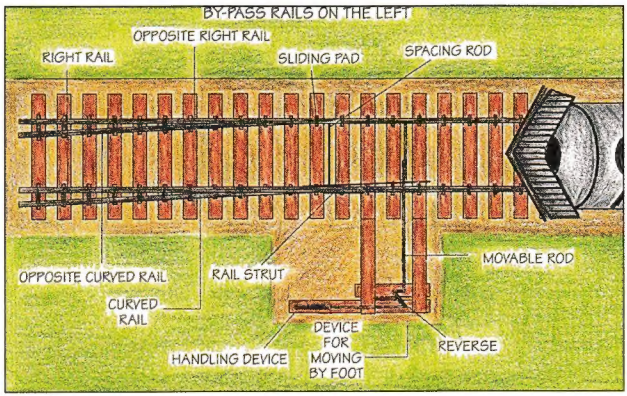


Illustration by Mimi Perrotti

Accidentally switching to another track could result in the derailment of one or more trains. So special devices keep the switching mechanism in a fixed position as trains pass over it.

Train switches consist of short moveable rails that turn on pivots at points where they meet other tracks. By turning a switch, a train can be moved from one track onto another and continue on a re-directed route.

Switching Switches

Once every switch was done by railroad workers who moved the switch-levers by hand before the train reached the crossover point. Today, switching is handled by telecommunications. At a computer center, a train dispatcher closely monitors the movements of many trains, much like an air traffic controller monitors the flights of many planes. With a touch of a button, the dispatcher simultaneously handles the switching of all trains in the vicinity. Switching tracks is carefully calculated to avoid any collision of trains traveling in the same area.

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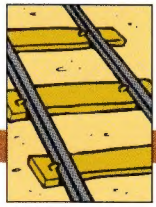
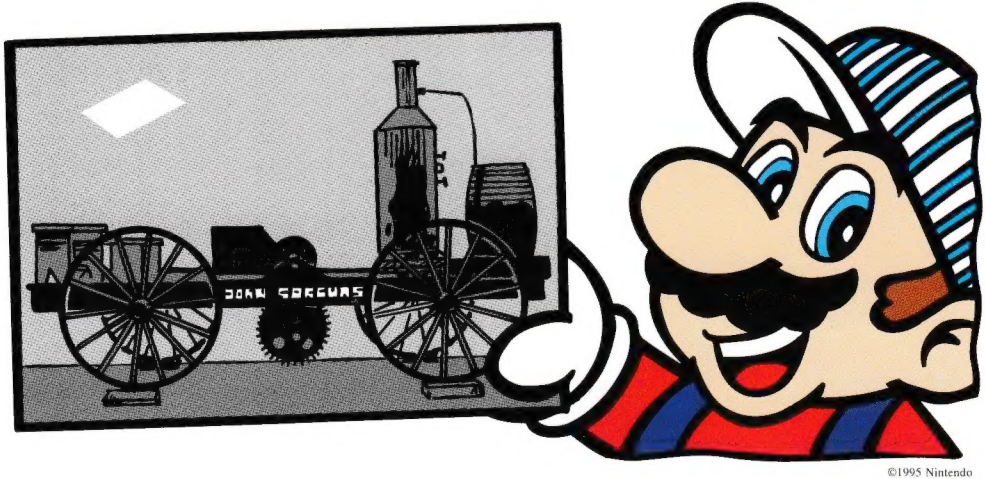
When was the steam train invented?



LAND TRANSPORTATION

1. In the 1700s
2. In the 1800s
3. In the 1900s



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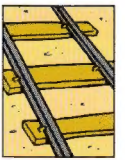
Steam Locomotive

In the early 1800s, Richard Trevithick of England built an engine that used high-pressure steam to propel it on a track. Before long, steam engines puffed along carrying freight and passengers from country to country.

2 The steam train was invented in the 1800s.



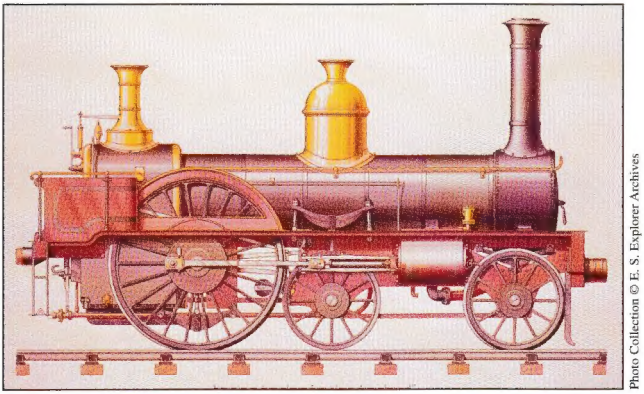


Photo Collection © E. S. Explorer Archives

Steam locomotive by Robert Stephenson, son of the man who designed "Locomotion."

It was in 1804 when Trevithick demonstrated the power of his engine by having it pull 10 tons (9 metric tons) of iron, 70 men, and 5 wagons on a track for 9.5 miles (15 km), making it the first railroad locomotive. In 1825, "Locomotion," designed by George Stephenson, pulled 28 wagons. To lessen the noise, he added a smokestack that increased the amount of steam produced. Stephenson's railroad ran freight trains and, in 1830, booked its first passengers for a 30-mile (48-km) trip.

The End of Steam

Beginning in 1930, diesel and electric engines slowly replaced most steam engines. But in some countries, like India and China, and in special amusement parks, they still chug along the iron rails.

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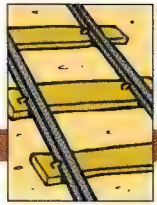
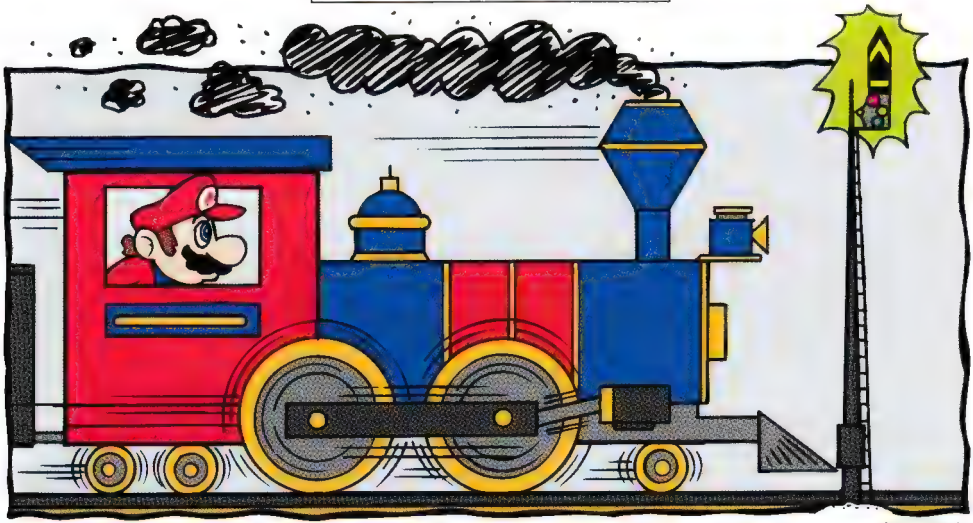
What kind of signals do trains use?



LAND TRANSPORTATION

1. Smoke signals
2. Semaphores
3. Hand signals



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Semaphore

Train tracks, like any main road, have their "traffic lights," the semaphores, which are positioned at regular intervals along the route.

2 Semaphores are used to signal trains.

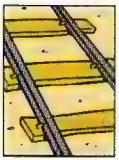

Photo © Bohn / Explorer

The light tells the engineer to stop before the train reaches the signal.

As trains travel the country, those moving in the same direction pass on the left, just as cars do. Dispatchers monitor the movement of every train to avoid one catching up with another and having no place to pass. But how does the engineer on one train know if there is another train moving on the same track? He checks the semaphores.

Traffic Lights

Using mechanical signals, a dispatcher lights a red target above the tracks to relay a command to a train engineer to stop the train before it reaches the signal. After the train stops, the dispatcher may use light signals to indicate that the section ahead is clear but that the engineer must proceed slowly. All along the line, other light panels signal trains to stop or slow down for track switching or congested areas of traffic ahead. As with other traffic signs, green signals all clear ahead.

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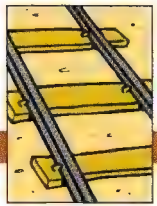
How fast does the world's fastest passenger train go?



LAND TRANSPORTATION

1. 186 miles (300 km) per hour
2. 285 miles (460 km) per hour
3. 319 miles (515 km) per hour

©1995 Nintendo

High-Speed Train

France's TGV (train a grande vitesse or high-speed train) is the world's fastest passenger train. Using power from an overhead wire system, it speeds along at 186 miles (300 km) per hour.

1 The fastest passenger train, France's TGV, travels 186 miles (300 km) per hour.

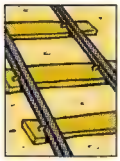


Photo © Nacivet / Explorer

A TGV zips across the countryside faster than any other passenger train.

France's TGV from Paris to Lyon, France, went into service in 1981. That year it hit a speed of 167 miles (269 km) per hour. This champion of the short, fast run improved its performance year after year and added trips from Paris to other cities in western France. Thanks to the speedy TGV, today people can travel between Paris and Marseilles in only 4 hours and 50 minutes instead of the 6 hours and 40 minutes it once took.

Train of the Future

In 1989, France's high-speed trains transported 20 million people. TGV hopes to carry more than 160 million passengers a year by the year 2000. To carry even more passengers, TGV engineers are studying the possibility of having two-story (double-decker) trains.

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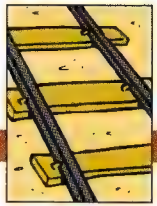
What is the Chunnel?



LAND TRANSPORTATION

1. A tunnel under the English Channel
2. A tunnel under New York's Hudson River
3. A tunnel under San Francisco Bay

©1995 Nintendo

Tunnels

The 31-mile- (50-km-) long "Chunnel," the world's longest underwater tunnel, links Folkestone, England, with Calais, France.

1 The "Chunnel" is a tunnel under the English Channel.

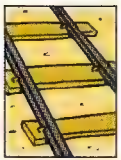


Photo © P. Cheuva / Explorer

The "Chunnel" allows trains to carry passengers, cars, and trucks 131 feet (40 m) below the English Channel.

Tunnels are dug through mountains or under waterways to provide short-cuts for cars, trucks, and railroads. Without tunnels, vehicles would have to travel around mountains or over water. Digging any tunnel is dangerous, but when digging underwater tunnels, like the "Chunnel" under the English Channel, flooding is a primary concern. To prevent this, the tunnel air is compressed to make its pressure greater than that of the water outside.

The Second Try

The Chunnel isn't the first attempt at tunneling between England and France. In 1882, the English began their first channel tunnel, using large tunnel-boring machines to dig through miles of rock. The machines had cut through 8,000 feet (2,400 m) before work stopped—government leaders feared enemy troops from Europe would invade via the tunnel! Today's "Chunnel" was begun in 1987 and officially opened in May of 1994.

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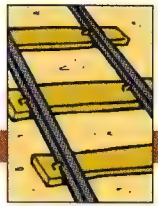
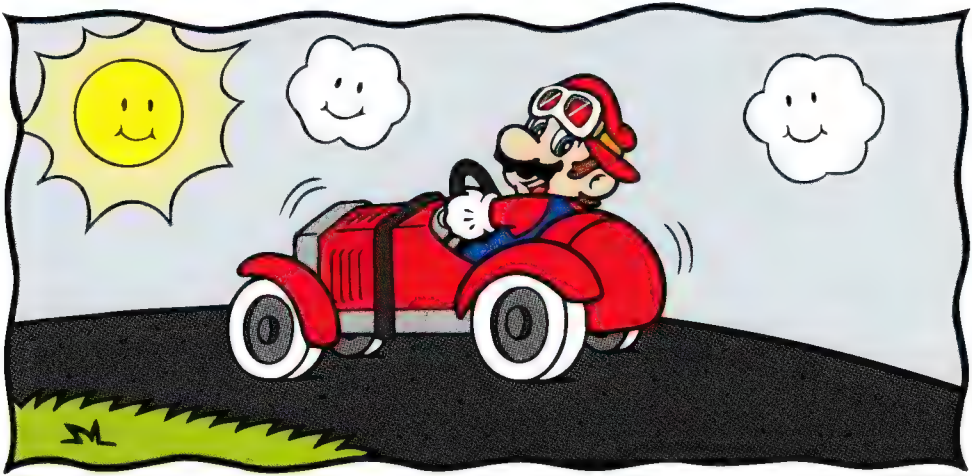
Which kind of car doesn't pollute the air?



LAND TRANSPORTATION

1. One that's powered by gasoline
2. One that's powered by wood
3. One that's powered by electricity



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Electric Cars

Electric cars are one solution to the problem of air pollution. So why don't you see more of them on the road?

3 A car that uses electric power doesn't pollute our air.

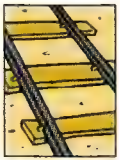

Photo © F.Chazot / Explorer

Auto makers still hope to make an electric car that will go farther and faster. Some models use solar panels to help refuel batteries.

In the 1800s, more Americans drove electric cars than gasoline-powered ones. But by the early 1900s, gas cars were more powerful, needed less refueling, performed better, and were cheaper to run than electric cars. By 1930, the electric car had all but disappeared. Then, in the 1960s and 1970s, people became concerned about air pollution and a dwindling oil supply. So interest in electric cars rekindled.

Electric Limitations

Specialty manufacturers started making electric cars again, but people did not buy them. The reason was simple: Electric cars need recharging after only 100 miles (160 km); a gas-powered car can go about 500 miles (805 km) before it requires refueling. Electric car batteries are expensive and, since they must fit into a small space, can't store much energy. Auto makers still hope that, in the near future, they can produce electric cars that meet the needs of both environmentalists and consumers.

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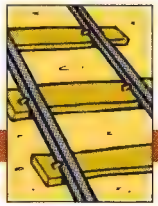
At a four-way stop, which car has the right-of-way?



LAND TRANSPORTATION

1. The car on the right
2. The car on the left
3. The car heading north

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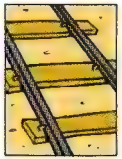
Right-of-Way

When driving a car or other vehicle, you must know the right-of-way rules to avoid accidents. Traffic lights and signals don't always solve problems. That's why right-of-way rules are important. Here are a few.

1 **The car on the right has the right-of-way at a four-way stop.**



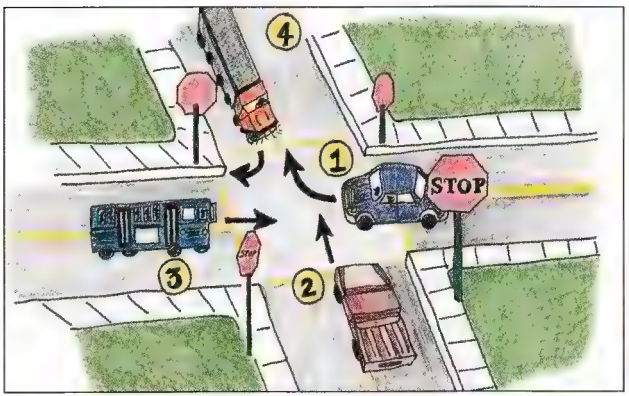


Illustration © Mimi Perrotti

The rules of the road take the confusion out of situations such as this.

Left or Not?

Imagine you reach an intersection. You plan to drive straight ahead, but another car's in the intersection, turning left. The right-of-way rule says you must let the other driver complete the turn before you enter the intersection.

Four-Way Stops

Now imagine an intersection where each corner has a stop sign—a four-way stop. Three cars reach the intersection at the same time and stop. Which car gets to go first? The rules state that the driver to your right has the right-of-way and can go first.

Special Circumstances

No matter who arrives first, some vehicles always have the right-of-way. Drivers must pull over to the right anytime they hear a siren or see the flashing lights of a fire engine, police car, or ambulance.

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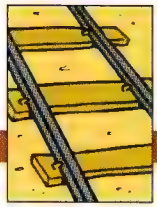
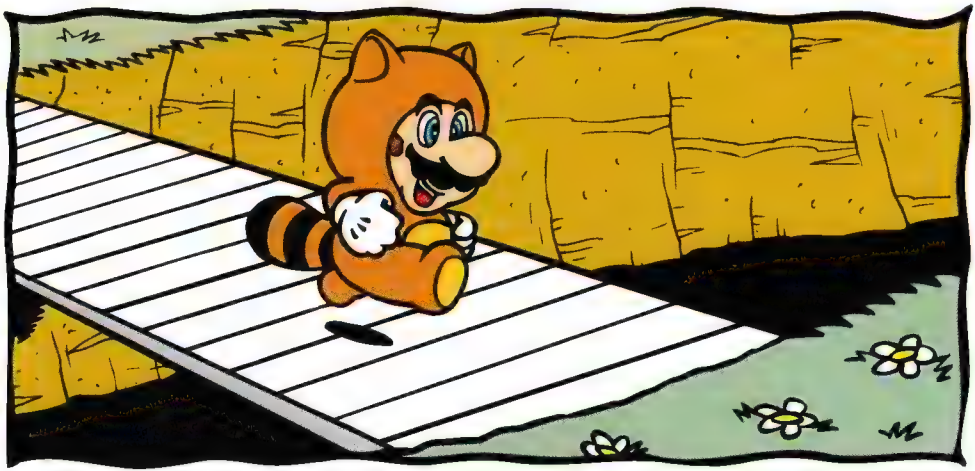
D3 054 16-12

Which are types of bridges?



LAND TRANSPORTATION

1. Declining, arch, suspension
2. Arch, suspension, cantilever
3. Arch, suspension, fibulating



©1995 Nintendo

Bridges

Bridges are designed in seven basic types: girder, truss, arch, cantilever, suspension, cable-stayed, and draw.

2 Arch, suspension, and cantilever are all types of bridges.

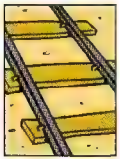


Photo © Courcau / Explorer

Suspension bridges in New York City link the boroughs of Brooklyn and Manhattan.

The first bridges were logs or vines that permitted a person to cross a river or gorge. Later, people built arch bridges, consisting of large blocks of stone wedged together to form an arch. Today we still have arch bridges, but they're made of concrete, wood, or steel.

Cantilever Bridges

Cantilever bridges have two independent beams extending from opposite banks of a waterway. A third beam connects the two above the middle of the waterway. Cantilevers, spanning up to 1,800 feet (549 m), are usually built of steel or concrete.

Suspension Bridges

Suspension bridges span long distances. The roadway hangs from steel cables that are supported by two high towers. The best-known suspension bridge in the U.S. is San Francisco's Golden Gate Bridge, with a main span of 4,200 feet (1,280 m) and a total length of 8,981 feet (2,737 m).

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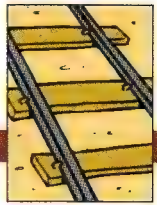
What is the center of a wheel called?



LAND TRANSPORTATION

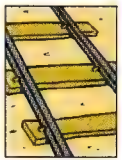
1. The rim
2. The axle
3. The hub

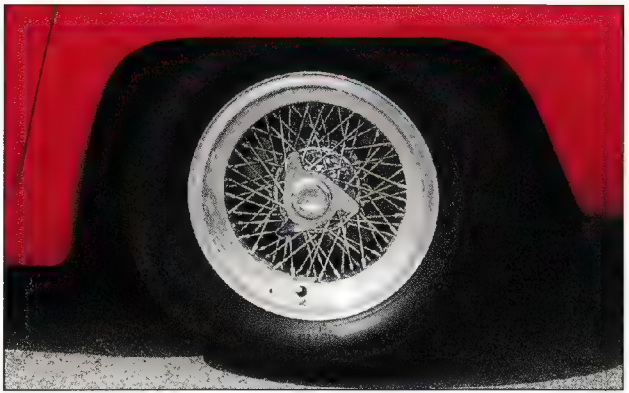
©1995 Nintendo

Wheels

The wheel was invented about 5,000 years ago. At first, wheels were carved from wood. Today, wheels may be spoked or solid and come with or without tires. Each has a shaft or axle attached through its center or hub.

3 The center of a wheel is the hub.





© D. Prest / Explorer

Some cars have fancy hub caps holding the tires on the axle. When replacing a flat tire, you can see the axle on which the tires are mounted.

The wheel and axle is one of the three basic simple machines—the other two are the inclined plane and the lever. A machine is any device that helps us perform work. The oldest known wheeled vehicles, chariots dating from 3500 B.C., were found in Mesopotamia, an ancient southwest Asian region. (Most of Mesopotamia, home of early civilizations, is part of Iraq today.)

Turning Wheels

Wheels have important uses other than transportation. In 3000 B.C., an Egyptian turned a cart wheel horizontally and put a lump of clay on its hub and invented the potter's wheel. Later inventions like the water wheel, spinning wheel, windmill, and wheelbarrow became equally important in making work easier.

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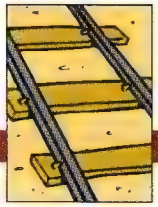
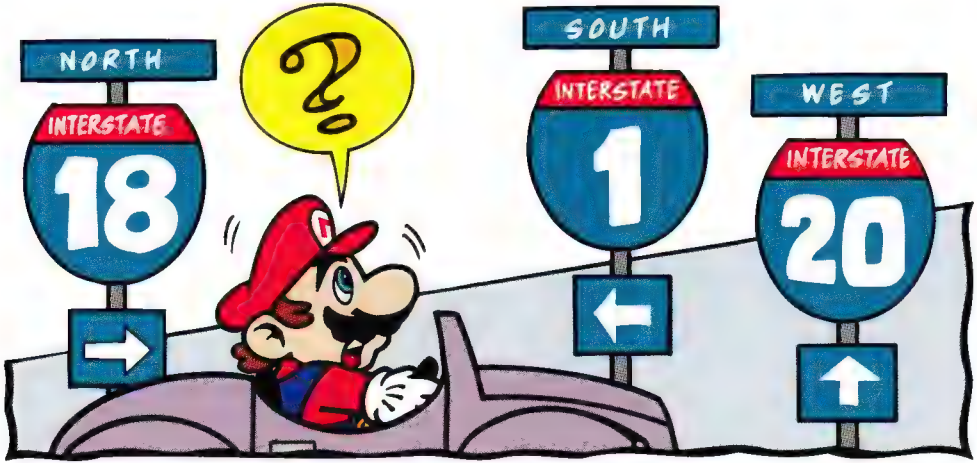
How are U.S. highways numbered?



LAND TRANSPORTATION

1. East and west roads have even numbers.
2. North and south roads have odd numbers.
3. Both of the above



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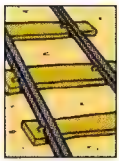
Highways

Highways going east and west have even numbers, like Interstate 70 which starts in Ohio and runs all the way to Colorado. Those going north and south have odd numbers, such as U.S. 95, which runs from Maine to Florida.

3 **U.S highways going east and west have even numbers; those going north and south have odd numbers.**



© Superstock

Today people can travel from California to New York or Canada to Mexico on superhighways.

Early American roads were crude paths leading from a wharf to a town, so people could move supplies from a ship to their homes or shops. Today, the U.S. has a system of interstate highways linking more than 75 percent of the cities with populations over 50,000.

Hard Surface Roads

The first hard surface road in the U.S. was built in 1794. The Lancaster (Penn.) Turnpike was a 62-mile (100-km) road made of hand-broken stone and gravel. Other hard surface roads, called corduroy roads, were made of logs.

The first U.S. freeway, the Pennsylvania Turnpike, opened in 1940. (Freeway refers to the "free" flow of traffic.) Today you can recognize interstate highways by their distinctive red, white, and blue road signs shaped like shields.

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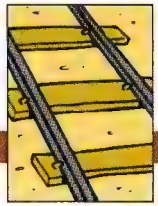
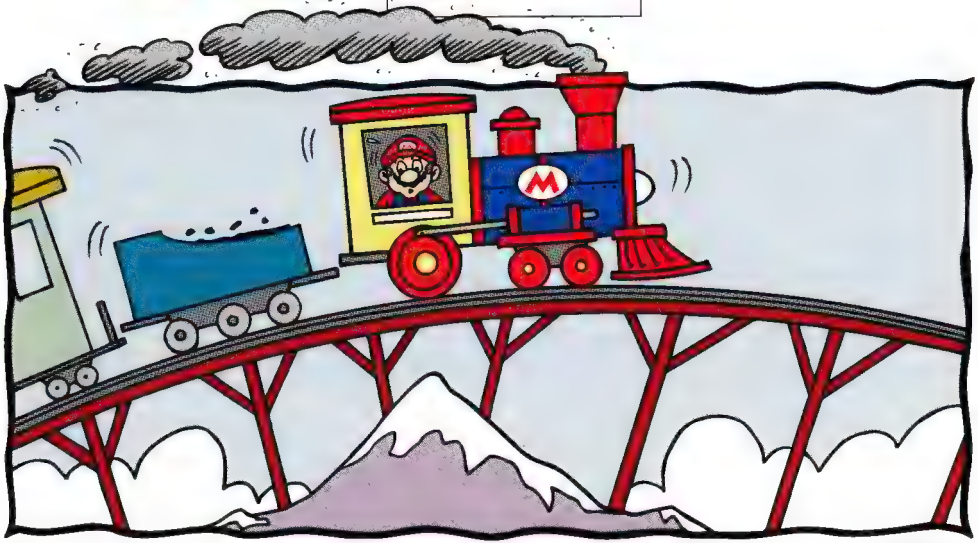
In which country would you find the world's highest train?



LAND TRANSPORTATION

1. Peru
2. India
3. Nepal

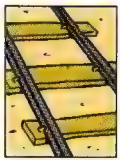


©1995 N.ntendo

Andes Train

Begun in the late 19th century, Peru's Central Railway runs from Lima, the capital, to towns, mines, and ore refineries high in the Andes. The train climbs to 15,844 feet (4,829 m) above sea level, making it the world's highest standard-gauge train.

1 The world's highest train is in the Andes mountains of Peru.



© J. P. Courau / Explorer

Because there's engine stress when pulling a train to such high altitudes, engineers switch locomotives several times during the journey up the Andes.

The train links Lima with La Oroya, 110 miles (177 km) away. Building the track through the rocky Andes required thousands of tons of explosives.

A Scenic Journey

A trip up the mountain takes a few hours. Along the way, the train passes through 66 tunnels, over 59 bridges, and around 22 hairpin turns. It goes through La Galera, whose train station, at 15,587 feet (4,751 m), is the world's highest train station on a standard track. At the highest point of the journey, some passengers have trouble breating because of the lack of oxygen in the air. The train carries oxygen tanks to help passengers, but sometimes passengers get off and take another form of transportation down the mountain.

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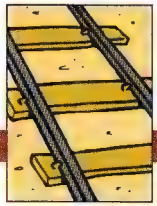
Who built the Model T?



LAND TRANSPORTATION

1. Ralph Modell
2. Henry Ford
3. M. T. LaSalle

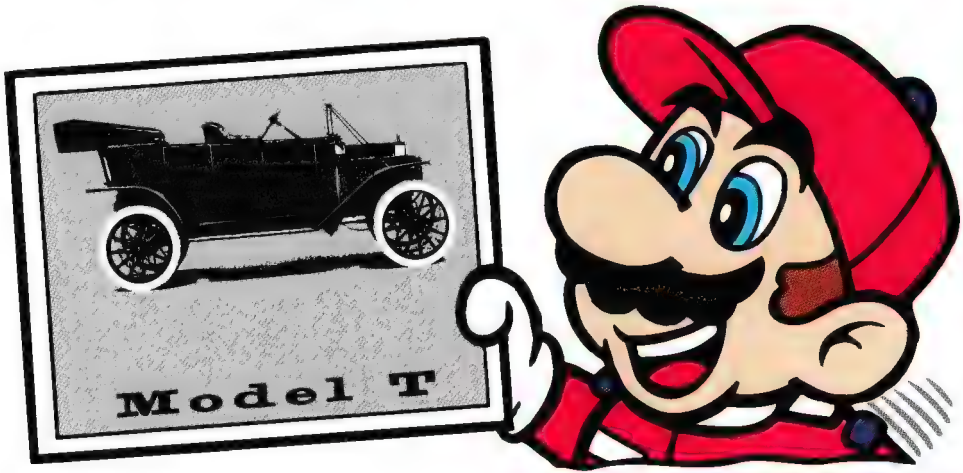


Illustration: Gary Fields

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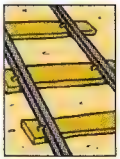
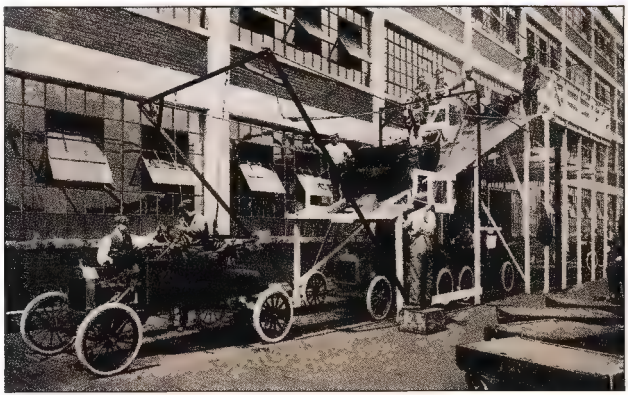
Henry Ford

Henry Ford (1863-1947) was the leading American car maker in the early 1900s. His Model T and Ford Motor Company assembly line changed the auto industry forever.

2 Henry Ford, founder of the Ford Motor Company, built the Model T in 1908.





© From the Collections of Henry Ford Museum & Greenfield Village

This was the final assembly line at the Ford Motor Company's Highland Park plant in 1913.

Born in what's now Dearborn, Michigan, Henry Ford became interested in cars as a young man. He built his first car in 1896 and started his own company in 1903, making expensive cars like everyone else. But Ford wanted to make a car that was simple, sturdy, and affordable.

Ford's Dream Come True

Ford's Model T cost $850, too much for many people. By using assembly lines on which each worker did just one thing and making his own parts instead of buying them, Ford could finally sell his car for $260, affordable for the average family. By 1927, more than 15 million Model Ts had been sold. In Dearborn, Ford founded the Ford Museum and Greenfield Village, a group of restored historical buildings. The museum has exhibits on science, industry, and art, and the first car Ford built.

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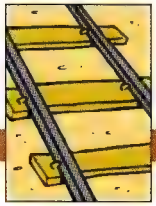
When was the first gasoline-powered motorcycle built?



LAND TRANSPORTATION

1. 1675
2. 1742
3. 1885

Illustration: Gary Fields

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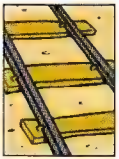
First Motorcycles

In 1885, a German named Gottlib Daimler combined a bicycle with a gasoline powered engine . The previous year an Englishman named Edward Butler had mounted a similar engine on a tricycle.

3 The first gasoline-powered motorcycle was built in 1885.



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Dirt bikes are a type of "off road" motorcycle.

The French and the Belgians were the first to design practical motorcycles, soon to be followed by the British, Germans, Italians, and Americans. After 1910 motorcycles appeared on roads throughout the world. During World War I (1914-1918) they were used in all branches of the armed forces, particularly by messengers. From the end of World War I until the depression began in 1929 motorcycle racing was a popular sport. With the start of World War II in 1939, motorcycles once again became important military vehicles.

After World War II the interest in motorcycles spawned a renewed interest in other motorized two-wheeled forms of transportation such as scooters, mopeds, and more recently, dirt bikes. Motorcycle racing also regained its popularity.

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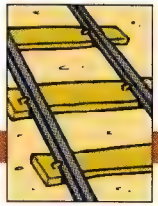
What is the Orient Express?



LAND TRANSPORTATION

1. Another name for the Concorde
2. A subway in Tokyo
3. A European transcontinental train

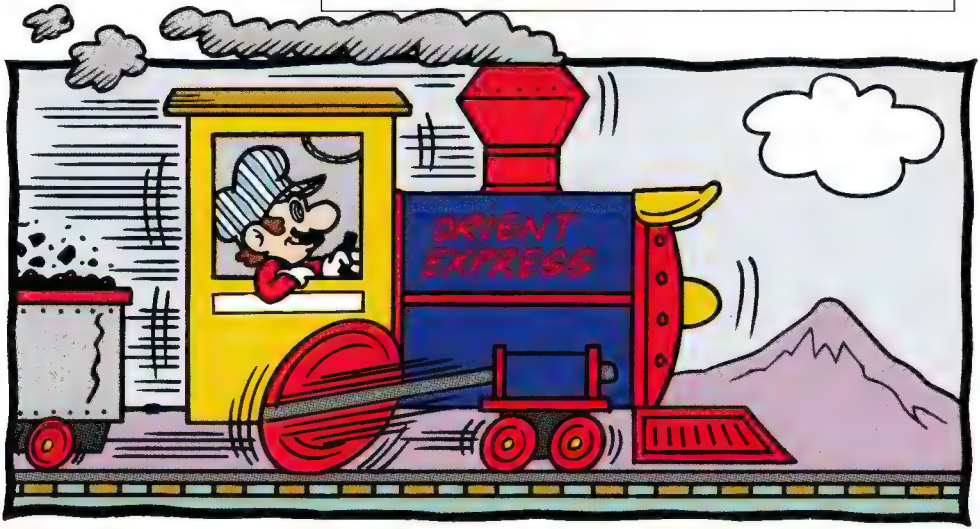


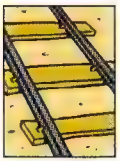
Illustration: Gary Fields

©1995 Nintendo

Orient Express

The Orient Express was Europe's first transcontinental express train. It is famous worldwide for its luxury and comfort.

3 The Orient Express is a European transcontinental train.



© Sipa Icono

The Orient Express railways were closed down during World War II.

From 1883 to 1977, the Orient Express—or more correctly since 1919, the Venice-Simplon-Orient-Express—traveled from Paris to Constantinople (now Istanbul), Turkey. Before airplanes, the Orient Express was the fastest, most comfortable way to make this long trip. It's still the most luxurious. Today, the Orient Express makes shorter trips over parts of its original route and is a favorite of vacationers. Many writers have used the Orient Express as a setting for their stories of mystery and romance, such as, Agatha Christie's *Murder on the Orient Express*.

Other Luxury Trains

There are other trains similar to the Orient Express. The Blue Train makes a 26-hour trip once or twice weekly between Pretoria and Cape Town, South Africa. The elegant Indian Pacific crosses the entire Australian continent—from Perth to Sydney—in less than three days.

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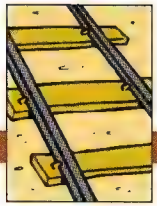
Who improved sleeping cars in trains?



LAND TRANSPORTATION

1. George C. Scott
2. George Mortimer Pullman
3. Jesse James

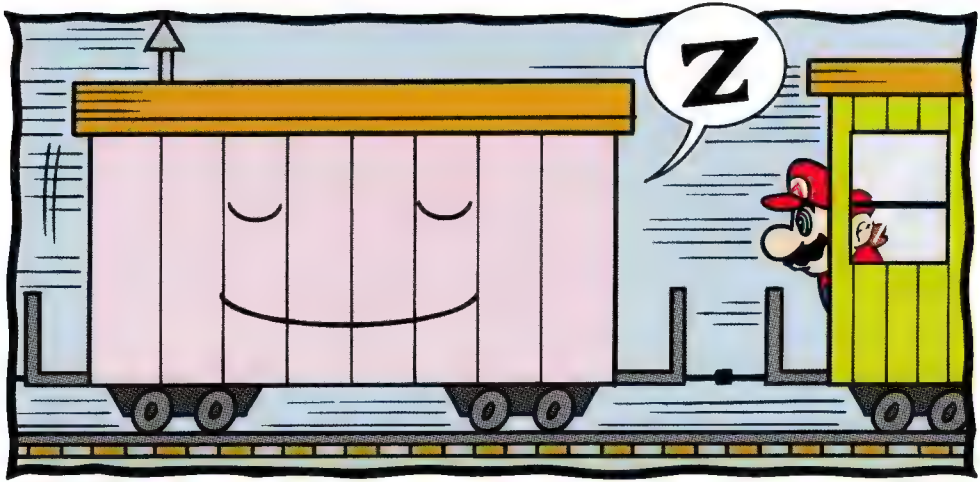


Illustration. Gary Fields

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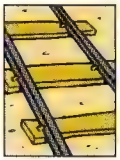
Train Travel

Before airplane travel became popular, long trips were usually made by train. George Mortimer Pullman is remembered for his innovative ideas that made train travel more appealing.

2 George Mortimer Pullman improved sleeping cars for the train.



© M. Renaudeau / Hoa Qui

Pullman redesigned the sleeping car and added other improvements to train travel.

George Mortimer Pullman (1831-1897) worked as a cabinetmaker and a construction contractor before moving to Chicago in 1855. There he helped improve the sleeping cars then in operation. Later, he and his friend Ben Field designed a larger, more elaborate sleeping car they dubbed the Pioneer. It was equipped with seats that could easily be converted into beds and separated by curtains for privacy.

Pullman Palace

In 1867, Pullman founded the Pullman Palace Car Company, later known as the Pullman Company. His firm built and operated sleeping cars on all major railroads, monopolizing the business in the United States by 1889. The company's manufacturing plant was located in Pullman, Illinois, a city built and owned by the Pullman Company. Today this city is part of Chicago.

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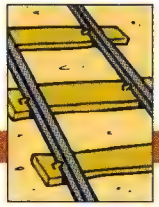
What is the Trans-Siberian Line?



LAND TRANSPORTATION

1. A Russian railroad
2. A shipping company
3. A pipeline

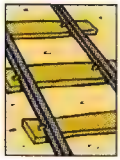
Illustration: Gary Fields

©1995 Nintendo

Railroads

The Trans-Siberian railroad was completed in 1916 and remains the longest rail line in the world to date.

1 The Trans-Siberian Line is a Russian railroad.



© G. Boutin / Hoa-Qui

It took thousands of people to build the Trans-Siberian Railway. Most of them were criminals, peasants, or political prisoners.

The construction of the Trans-Siberian Railway began in 1891. This railway was a continuation, in both directions, of the line which linked Chelyabinsk to Moscow, a distance of 1,054 miles (1,700 km). It is approximately equivalent to the distance between Boston and Chicago. In the 1970s it took eight days for a passenger train named the Russia to travel the 5,750 mile (9,250 km) rail. This is almost twice the distance from San Francisco to Washington, D.C.

A Vital Railroad

Today the railway branches off the main line in many directions allowing access to regions such as Siberia, Lake Baikal, and Manchuria. Access to Siberia is vital as this massive region is extremely rich in mineral, gas, and oil resources. The connection to the Chinese Eastern Railway in Manchuria allows the Russians a route across Asia. Many of these railway lines have been electrified today thereby cutting energy costs and pollution.

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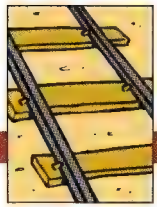
When was the first Rolls-Royce built?



LAND TRANSPORTATION

1. 1906
2. 1920
3. 1950

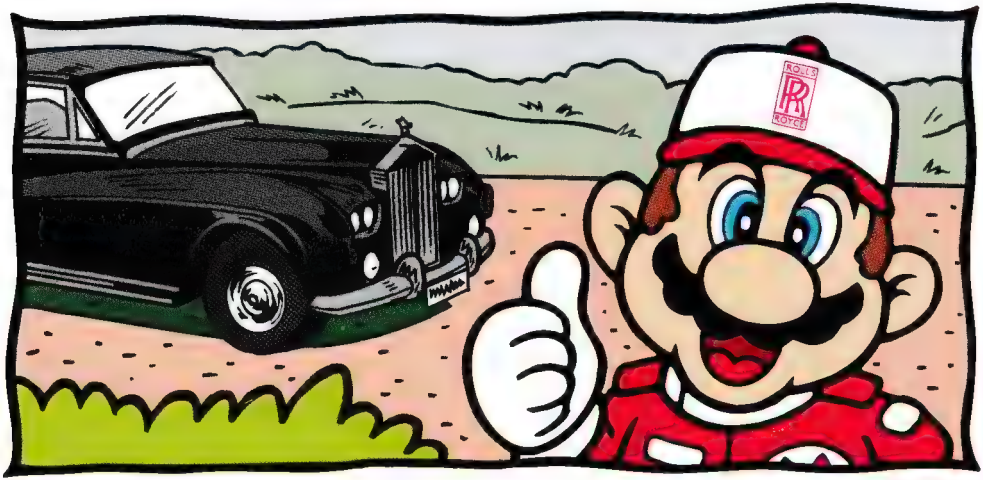


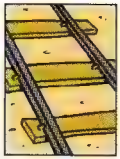
Illustration: Gary Fields

©1995 Nintendo

Rolls-Royce

Charles Rolls, a wealthy motorist and aviator, who managed a car sales company, and Henry Royce, an electrical equipment manufacturer, founded the Rolls-Royce automobile company in 1906.

1 The first Rolls-Royce was built in 1906.



© Len Sirman

Rolls-Royce car names stimulate the imagination: Silver Cloud, Silver Ghost, Phantom, and Silver Shadow.

Their first car, the Silver Cloud, was considered the best car in the world in 1915. Two intertwined R's are featured on the radiator grille and a flying female figure, the Spirit of Ecstasy, is the logo ornament located on all Rolls-Royce hoods.

Land and Sky

At the start of World War I, Rolls-Royce branched out into the manufacture of airplane. Engines for planes such as Spitfires, Caravelles, and the Concorde, among numerous others, are Rolls-Royce products. This part of the business was so successful that it became the primary source of income for the company. In 1971 Rolls-Royce went bankrupt. The British government took over the jet-engine division, thereby allowing it to survive.

In 1987, Rolls-Royce became a private company once again for both the manufacturing of automobile and jet-engines.

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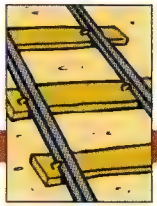
What is a driving competition?



LAND TRANSPORTATION

1. A running race for Motor Vehicles Department employees
2. A sport involving horses
3. Frog racing

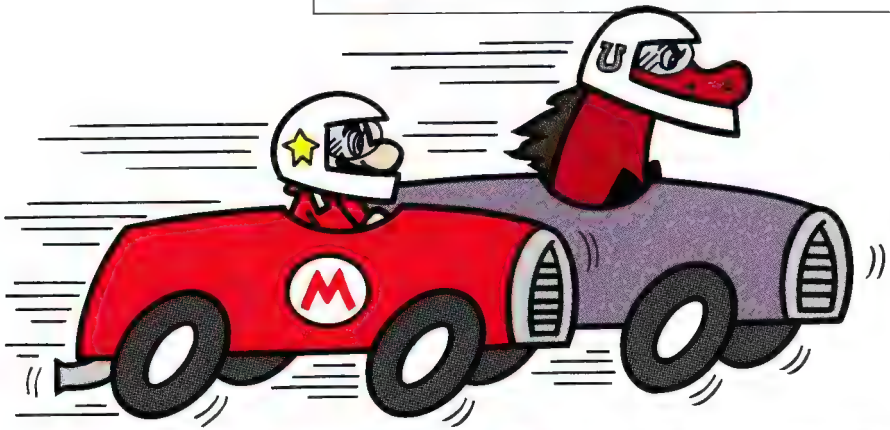


Illustration Gary Fields

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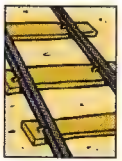
Driving Competitions

Before there were automobiles, people rode in horse-drawn vehicles. Today, some people race horse-drawn carts as a hobby.

2 **In driving competitions, people show their skills at guiding horse-drawn vehicles.**



© Sunset

Elegance and style are important criteria in judging driving competitions.

Horse-driving was a necessity up to the World War I. With the invention of motor cars, the art of horse driving gradually faded. Today, some people keep the skill alive as members of driving clubs. These clubs organize rallies and competitions where people can test their horse-driving skills.

Three-Part Competition

There are three parts to a driving competition. The first is presentation and dressage, which shows the driver's control of the horse. The next is the marathon, a speed and endurance test that may be up to 17 miles (27.2 km) long. The final phase, obstacle driving, tests the horse's fitness after the previous day's marathon.

Driving is an expensive sport: people must acquire their own harness, carriage, and horses. But it can also be a very pleasurable escape from the harried world of machines.

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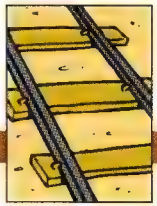
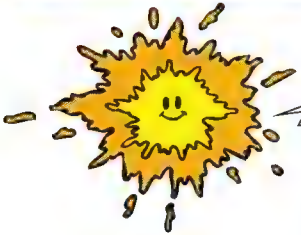
When was the bicycle invented?



LAND TRANSPORTATION



1. Late 17th century
2. Early 19th century
3. Mid-20th century

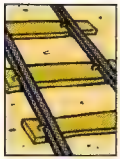
Illustration, Gary Fields

©1996 Nintendo

Bicycle

An early bicycle called a *célérifère* was developed in the 1690s in France. It had no handlebars, and its wheels were attached to a wooden beam. The rider sat on a cushion on this beam, moving and steering with his or her feet.

1 The bicycle was invented late in the 17th century.



© Gaillard / Jerrican

Learning to ride a bike takes patience and persistence. Bike riding is a practical skill you can use your entire life for transportation, exercise, and pleasure.

The first two-wheeled vehicle with a steering device was invented by a German nobleman in 1816. Named the draisine, after the inventor, it had a pivoting handlebar that turned the front wheel.

In 1839, Kirkpatrick Macmillan from Scotland added driving levers and pedals to the draisine. This made it possible to move forward with the feet off the ground.

Modern Bicycles

The French crank-driven, loose-pedaled vélocipède, popular around 1855, was the first modern bicycle. Its wheels and frame were wooden, and its tires were iron. The front wheel was taller than the back wheel.

The first machine to be patented under the name bicycle was developed in 1869 in England. It had solid rubber tires mounted on steel wheel rims.

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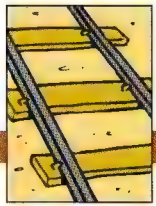
What is a speed limit?



LAND TRANSPORTATION

1. Maximum speed at which a plane is capable of flying
2. Laws governing how fast cars may travel
3. The fastest that people can talk

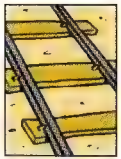
Illustration: Gary Fields

©1996 Nintendo

Speed Limit

In 1995, the U.S. government removed the federal highway speed limit of 55 miles per hour (88 km/h), and let states determine highway speed limits.

2 A speed limit is a law governing how fast cars may travel.



© Nathan Olshin

Speed limit signs inform motorists of the maximum allowable speed for the road on which they are travelling.

Cars must travel at different speeds depending on the roads they're on. In busy areas, such as shopping districts, speed limits are usually about 35 miles per hour (56 km/h). Near houses and schools the speed limit might be lower. This makes conditions safer for drivers and pedestrians. Traveling at slower speeds, drivers are better able to avoid accidents.

Highway Driving

On highways with little traffic and no pedestrian crossings, cars travel at high speeds. Originally, states set highway speed limits. The limits were usually higher in western states, like Montana, with long, flat stretches of road and few cars. But in 1974, when the U.S. was fighting a gasoline shortage, the federal government instituted a 55 mile per hour speed limit in all states. Driving slower helped conserve fuel. In 1995, the federal speed limit was removed and states once again set highway speed limits.

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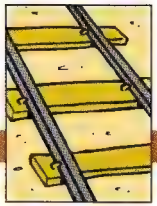
How does a taxi driver know how much to charge?



LAND TRANSPORTATION

1. By the number of passengers
2. All cab fares are the same.
3. A meter calculates the fare based on distance traveled.

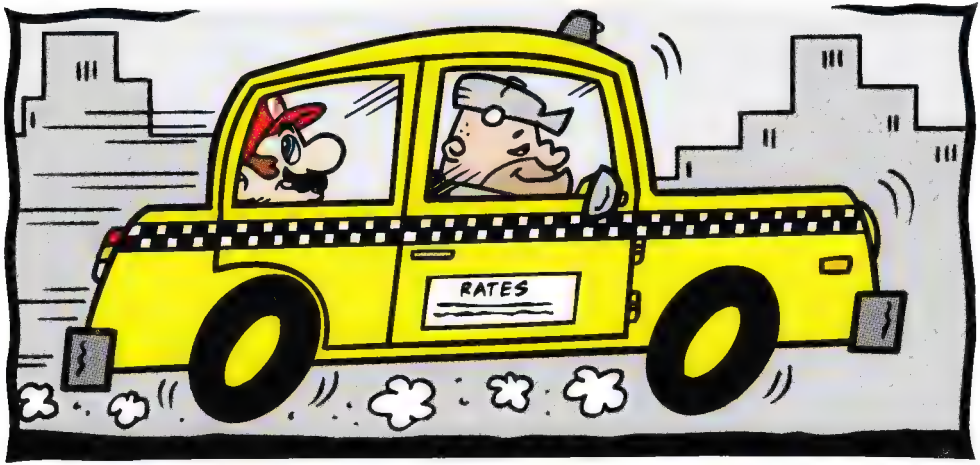


Illustration: Gary Fields

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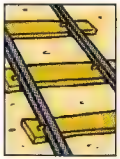
Taxi

The first motorized taxicabs were in Paris, France, in the 1900s. Today there are motorized taxis all over the world.

3 Taxi meters calculate the distance traveled to determine the fare.



© Len Sirman

In New York City most taxicabs are painted bright yellow. Horse-drawn cabs are a favorite way for visitors to tour the city and see the sights.

Before there were cars, there were cabs. The word cab is short for cabriolet, a type of two-wheeled, horse-drawn carriage that was hired to transport passengers from place to place. Horse-drawn cabs were popular in Europe in the 1800s, especially in cities where it was hard for people to maintain their own stables.

A New Invention

Taxi fares are determined by the distance traveled. Because every trip is different, it was hard to figure out exact fares. To solve the problem, in 1891, German inventor Wilhelm Bruhn built a device called a taximeter which measured the distance the cab traveled and multiplied it by a set fee per mile (km). The word taximeter came from the Latin word *tax,* meaning fee, and the Greek word *meter,* meaning a measuring device. Cabs equipped with taximeters became known as taxicabs.

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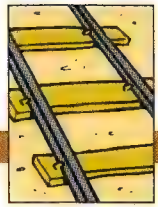
What shape is a stop sign?



LAND TRANSPORTATION

1. Octagon
2. Triangle
3. Square

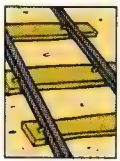
Illustration Gary Fields

©1996 Nintendo

Traffic Signs

Road signs alert drivers to rules they must follow. They also warn drivers about road conditions and possible hazards.

1 **A stop sign is a red octagon, or eight-sided figure.**



© Nathan Olshin

No matter where it appears, a stop sign's distinctive octagonal shape and red and white coloring make it easy to recognize and understand.

Traffic rules and regulations make driving safe and pleasant for everyone on the road. Before a person can be licensed to drive, he or she must learn the rules of the road—including how to understand traffic signs.

Stop or Yield

The easiest sign to recognize is the stop sign. Stop signs are placed at intersections—points where roads cross each other. When drivers approach the intersection, they must stop to allow other cars or pedestrians to cross their path. Yield signs, usually upside-down red and white triangles, are similar to stop signs. At a yield sign a driver must slow down to give other cars the right of way.

Warning Signs

Some signs warn drivers about road conditions. They indicate when a road is slippery, when it curves sharply, or when other cars might merge with, or enter, the path of traffic. Warning signs are usually yellow with black letters.

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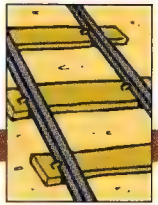
What is a velocipede?



LAND TRANSPORTATION

1. A kind of caterpillar
2. An early form of bicycle
3. An ancient Roman chariot

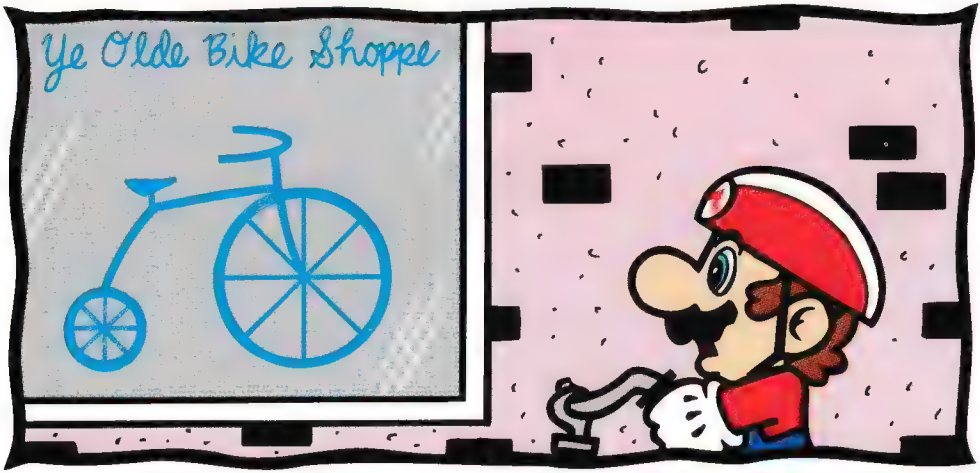


Illustration: Gary Fields

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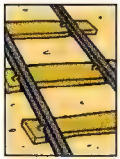
Bicycle

The first bicycles did not have pedals. Riders pushed them along with their feet.

In 1839, a Scottish blacksmith, Kirkpatrick Macmillan built a bicycle with pedals that drove the rear wheel, similar to the way bikes work today.

Meanwhile, a French inventor came up with the velocipede, a pedal-driven bike with a huge front wheel and small back wheel. Since pedals drove the front wheel, the larger the wheel the faster the bike could go. People took this idea to extremes. Some velocipedes had front wheels that were 5 feet (1.5 m) high! Falling off a bike like this could cause a serious accident.

2 **A velocipede is a bicycle developed in the 1860s.**



© Moulu / Sunset

Mountain bikes have thick tires and lots of gears so riders can take them "off-road" to rocky or hilly areas.

Practical Thinking

Things calmed down with the invention of the "safety bicycle" in the late 1800s. This bike had wheels of equal size and a chain and sprocket that drove the rear wheel. It was the model for the bikes we ride today. Adding pneumatic, or air-filled, tires made riding more comfortable, and gears made it easier to bike on different terrains.

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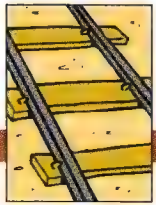
What powers streetcars?



LAND TRANSPORTATION

1. Atomic power
2. Electricity
3. Gas

Illustration, Gary Fields

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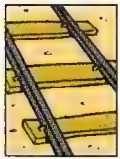
Streetcars

Sometimes called trolleycars, streetcars are electric-powered public transportation vehicles.

2 Streetcars are powered by electricity.



© R. Lanaud / Explorer

A trolleybus in France. Trolleybuses are powered by electricity from overhead wires. Unlike trolleys, or streetcars, they run on rubber tires without the need for tracks.

The first trolleys, used in the 1800s, were pulled by horses. They traveled on metal wheels along metal tracks installed down the center of city streets.

By 1900, horse-drawn trolleys were replaced with electric-powered trolleys. Larger cars which could transport more people were added, and trolley track was extended so people could commute from outlying neighborhoods to the center of town. With trolley service to connect various districts, cities grew into metropolitan areas.

Trackless Trolleys

Trolleys were efficient, but laying track was expensive and time-consuming. One alternative to electric trolleys was the trolleybus or trackless trolley. These vehicles are powered by electricity from overhead wires, just like trolleys, but they travel on rubber tires without the need for tracks. Because they're powered by electricity, trolleybuses don't create the noise and exhaust that ordinary automotive buses do.

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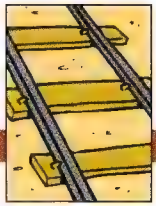
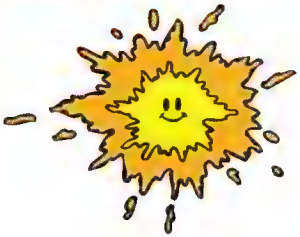
What kinds of vehicles use caterpillar tracks?



LAND TRANSPORTATION



1. Bicycles
2. Motorcycles
3. Tractors

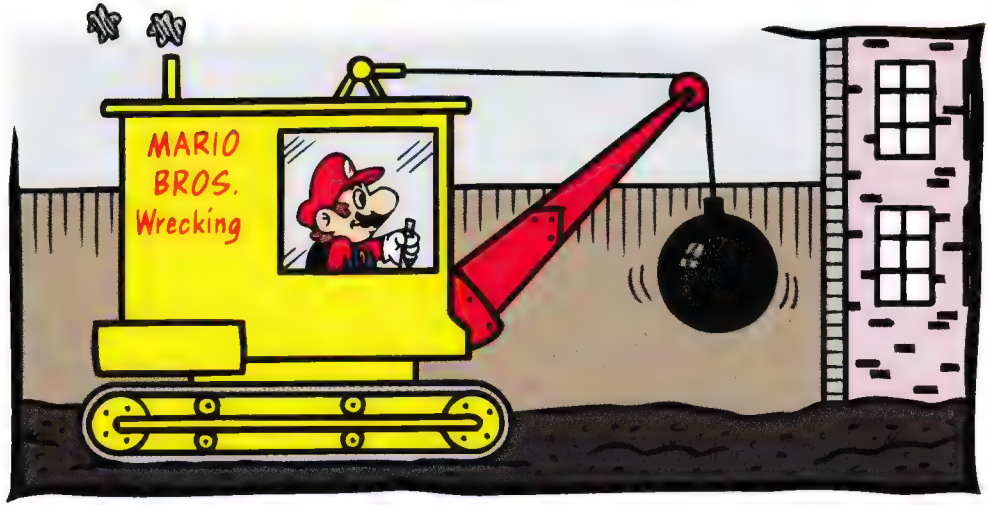


Illustration: Gary Fields

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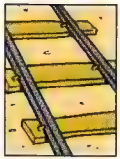
Track Vehicles

Track vehicles are designed to be used on all types of terrain —soggy, rocky, sloping, even snow-covered.

3 Tractors are one type of vehicle that uses caterpillar tracks.



© Len Sirman

Snow plows with caterpillar tracks can be used to clear roads even in the most severe winter conditions.

Cars and trucks can be used on rugged or difficult terrain, but what makes track vehicles different is the way their weight is distributed over their wheels. Instead of two axles—one near the front and one near the back—a track vehicle has a series of axles from front to back. The axles drive rubber or metal tracks which grip the ground and keep the vehicle from slipping. Because the weight is evenly distributed, the tracks won't sink into mud or muck the way ordinary tires will.

Farm to Battlefield

In the U.S. during the 1920s, the Caterpillar company began making track-type tractors. They could be used to work fields even in muddy conditions. During World War I, the U.S. Army used track vehicles to pull artillery and supplies across war-torn fields and muddy roads. By World War II, track vehicles became standard military equipment.

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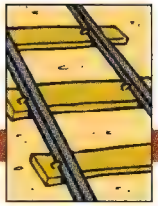
What is a catenary?



LAND TRANSPORTATION

1. A train used to transport animals
2. Overhead power lines for electrified trains
3. The braking system used for trains

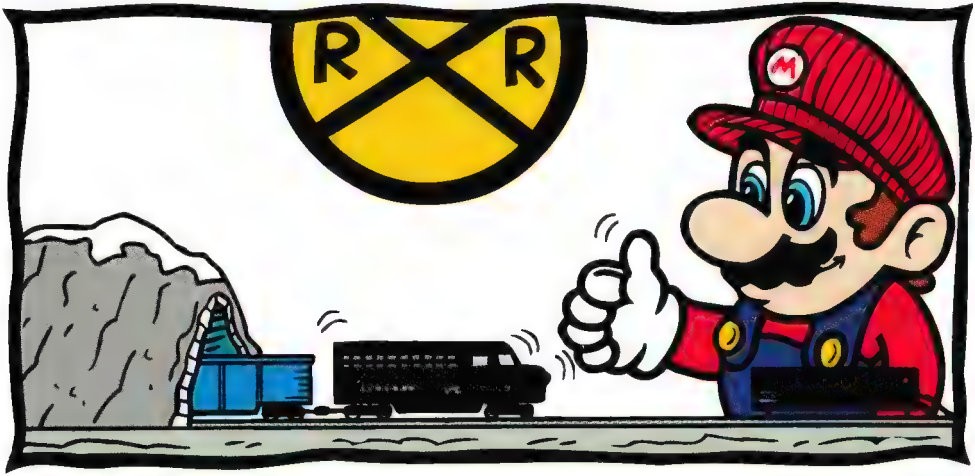


Illustration: Gary Fields

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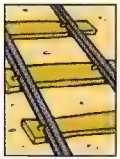
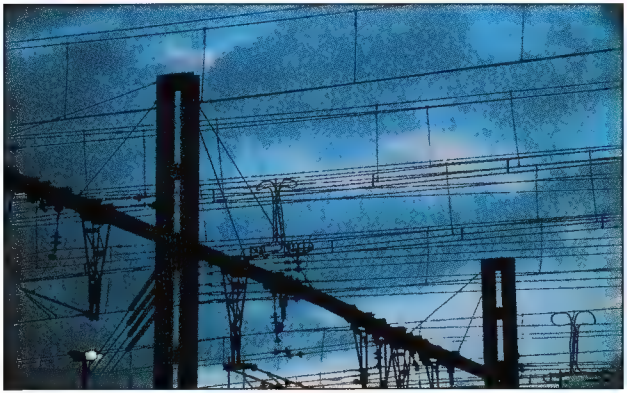
Electrified Trains

Trains powered by electricity do not produce the smoke and noise steam-powered locomotives do.

2 **A catenary is the overhead network of power lines used for electrified trains.**





© Len Sirman

An overhead system of electrical wires, called a catenary, provides power for electrified trains. A retractable current collector, called a pantograph, is attached to the top of the train. It elevates to touch the wires and draw power to the train.

In 1895, the Baltimore and Ohio Rail Road electrified a segment of track outside Baltimore. This was one of the first commercial uses of electrified train track in the world. Today local railroads throughout the U.S. have electrified part or all of their tracks. Amtrak, the U.S. nationwide rail system, also operates electrified trains on some routes.

Clean and Efficient

A system of electric trains costs a lot to set up. New track must be laid, and an overhead network of power lines—called a catenary—must be installed. In addition, separate power plants are sometimes needed to generate electricity to run the trains. Over time, however, electrified trains might be the most economical of all systems. Electric locomotives last longer than diesel locomotives, and the system is less costly to run.

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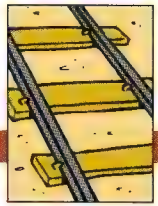
Why do cars have license plates?



LAND TRANSPORTATION

1. To show that the driver has passed a driving test
2. To show that the car has been registered
3. To tell other drivers where the car is from

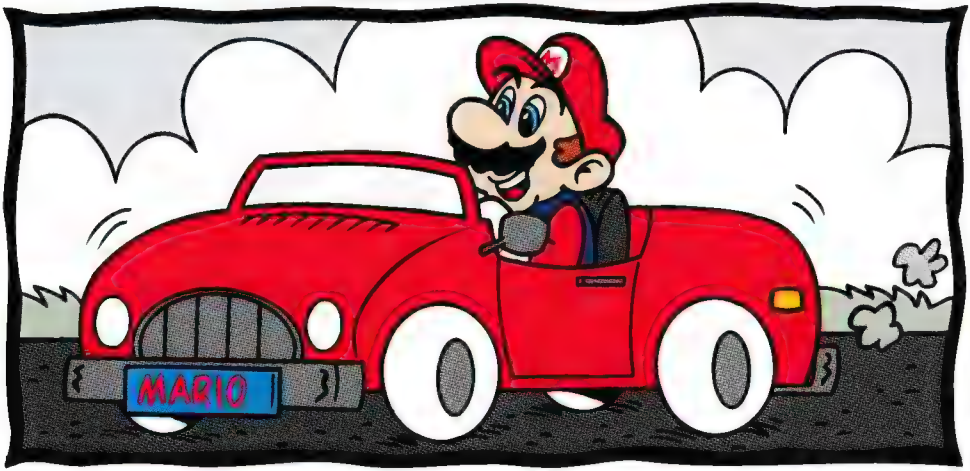


Illustration: Gary Fields

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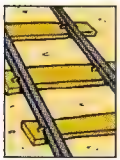
License Plates

Motor vehicles—cars, trucks, and motorcycles—must be registered before they can be driven. License plates show that an owner has paid a fee to register his vehicle.

2 **License plates show that a car has been registered with the state.**



© Len Sirman

In 1901, New York became the first state to require vehicle registration. Today there are more than 190 million motor vehicles registered in the United States.

Vehicle registration helps state governments keep track of the number of vehicles on the road. Part of the registration fee may be used to build and repair roads used by these vehicles. License plates also help police trace stolen cars. Knowing a plate number makes it easier for police to identify a car that's been stolen.

State Plates

Registration fees vary from state to state. In some states owners keep their license plates forever. In other states owners receive new plates each time they buy a new car. And of course each state has its own license plate design. Some states, such as Florida, give car owners many designs to choose from. For an extra fee, most states allow owners to choose their own plate numbers. These custom plates are known as vanity plates.

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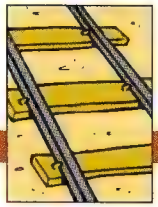
What determines a car's braking distance?



LAND TRANSPORTATION

1. Speed at which the car is traveling
2. State in which the car is registered
3. Size of the car's engine

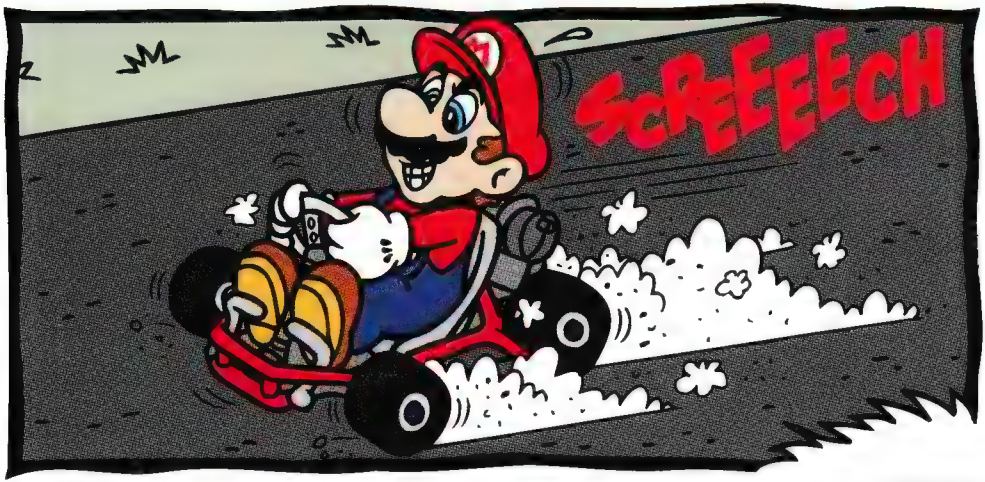


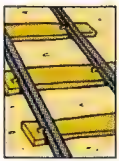
Illustration Gary Fields

©1996 Nintendo

Brakes

Braking distance is the amount of space necessary to bring a moving car to a complete stop. The faster a car travels, the longer its braking distance will be.

1 **The speed at which a car is traveling determines its braking distance.**



© P. Besson / Explorer

When roads are slippery cars require more braking distance.

A car's engine creates force to propel the car forward. To stop a moving car, the brakes must create an even greater force to counteract the car's forward motion. The faster a car travels, the more forward force it has and the longer it takes for the brakes to stop the car. So, a car traveling at 30 miles per hour (48 km/h) requires a braking distance of 78 feet (23.8 m). A car traveling at 70 miles per hour (113 km/h) needs 381 feet (116.1 m). These minimum braking distance figures include driver reaction time.

How Brakes Work

A braking system stops a car by preventing the car's wheels from turning. Stepping on the brake pedal creates pressure in the braking system. The pressure forces cushioned brake pads or shoes to press against a metal disk or drum inside the wheel. This causes friction which stops the wheel from turning.

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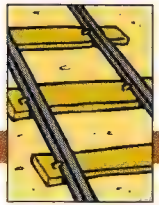
When did locomotives become streamlined?



LAND TRANSPORTATION

1. 1920s
2. 1930s
3. 1940s

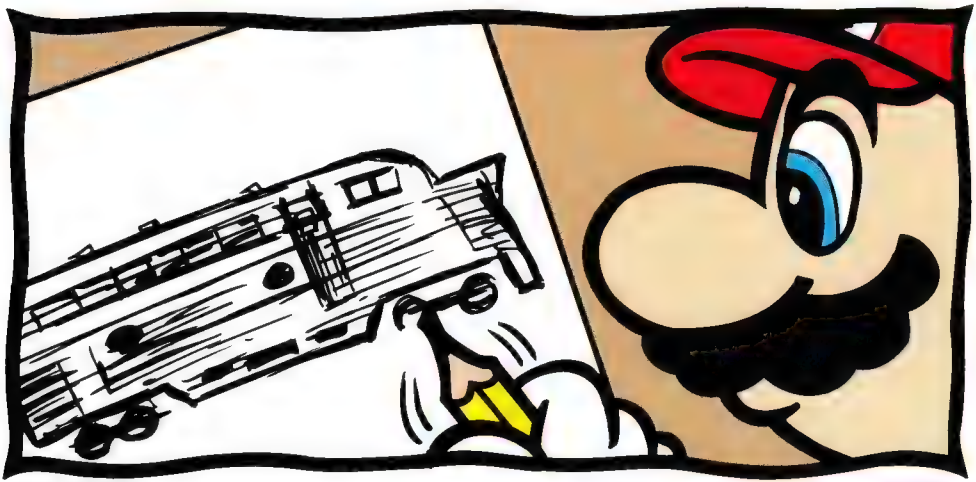


Illustration: Gary Fields

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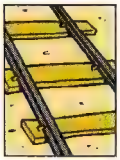
Locomotives

A locomotive pulls a train. In steam and diesel trains, the locomotive is like a power plant that converts raw fuel into energy to pull the train.

2 Locomotives adopted a streamlined design around 1930.



© T. Anderson-Fournier / Explorer

Old-fashioned steam locomotives, like this one, are still in use on some train lines. They're mainly used for recreation, not for regular passenger or freight trains. Behind the engine is the coal tender which carries the train's fuel supply.

Early trains had steam locomotives. They were strong and beautiful, and some could pull as many as 200 cars at once.

To generate steam to run the train, water had to be heated to the boiling point—and kept boiling—for the length of the journey. This was done with a coal-fired boiler. The boiler had to be continually stoked, or fed, with coal. So, steam locomotives were equipped with a coal car, called a tender, located behind the engine. Workers called stokers or firemen kept the boiler fed with coal.

Streamlining Trains

Some steam locomotives used oil instead of coal as fuel. This paved the way for diesel technology, in which oil fuels an electric motor in the locomotive. Diesel locomotives began to replace steam in the 1930s. Diesels were more fuel efficient, and they eliminated the need for the coal tender.

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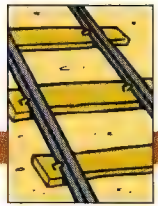
Where was the Jeep invented?



LAND TRANSPORTATION

1. England
2. Russia
3. United States

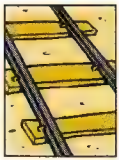
Illustration: Gary Fields

©1996 Nintendo

Jeep

The name "jeep" may have come from the "Popeye" comic strip! In the 1940s, it featured a character called Eugene the Jeep who made the sound "jeep" when he spoke.

3 The Jeep was invented in the United States.



© Len Sirman

The original jeeps produced in the 1940s were open-topped, all-terrain vehicles used by the United States Army. Today, Jeeps and other all-terrain vehicles are made for civilian use as well.

In the 1930s, the United States Army commissioned engineers to design and build a vehicle that could travel over rugged terrain like dirt roads and muddy fields. Ordinary cars just weren't tough enough. Officially, the vehicles were known as "general purpose" or "g.p." vehicles. But pretty soon, the name was shortened to "jeep." The first jeep was put into use in 1941.

Multi-Purpose Vehicle

Jeeps were conceived mainly for transportation, but during World War II some were equipped with anti-aircraft guns and used in combat. Reliable, sturdy jeeps also were used as field ambulances and for hauling field artillery.

During World War II, jeeps were made by several different automobile companies. Today, the Jeep name is a trademark of Chrysler Corporation, which makes Jeep brand vehicles for civilian use.

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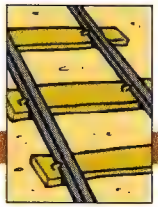
When should cars use headlights?



LAND TRANSPORTATION

1. At night
2. In foul weather
3. Both

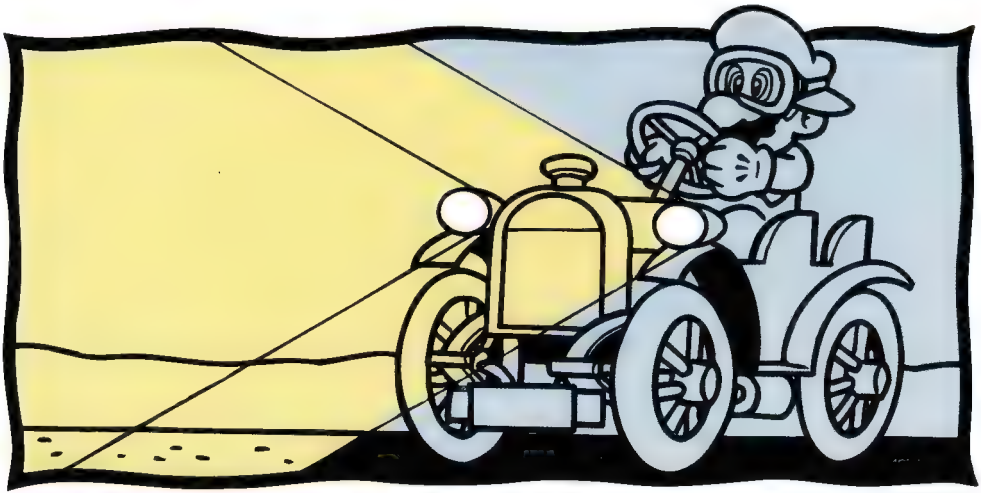


Illustration: Gary Fields

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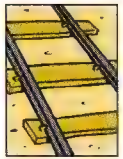
Car Lights

Cars are equipped with headlights so a driver can see the road ahead in darkness or foul weather.

3 Cars should use headlights at night and in foul weather.



© P. Forget / Explorer

Any time a driver switches on the windshield wipers he should switch on his headlights. Headlights make it easier for drivers to see and be seen in foul weather.

Headlights also make a car visible to other drivers. So, a driver switches on his headlights to help himself and other drivers. Every car has two white headlights and two red tail lights. Brake and signal lights operate separately from the headlights and tail lights. Brake lights are next to the tail lights, and newer cars have a third brake light centered above or below the rear window. Brake lights tell other cars that a driver ahead is slowing down. Signal lights, at the front and rear of the car, tell other drivers that a car will be making a turn.

Beam Me Up

Headlights have high and low settings. High beams illuminate the road about 500 feet (150 m) ahead. Low beams illuminate the road about 250 feet (75 m) ahead. For most night driving drivers use low beams. In fact, high beams can be dangerous in traffic because they distract other drivers.

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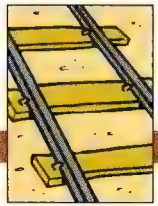
Why are cars equipped with seat belts?



LAND TRANSPORTATION

1. To help drivers see better
2. To activate a car's alarm system
3. To protect passengers and drivers in case of collision

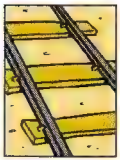
Illustration: Gary Fields

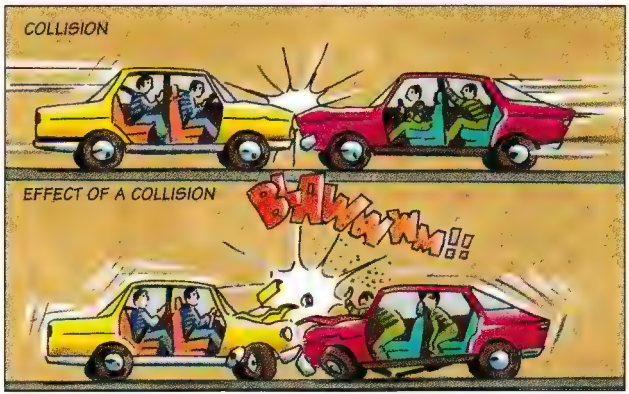
©1996 Nintendo

Seat Belts

People who wear seat belts are twice as likely to survive serious car accidents as those who don't wear seat belts. That's why most states have laws requiring drivers and passengers to wear seat belts.

3 Seat belts protect drivers and passengers in case of collision.





© Y. Tabaries

The force of a collision can send drivers or passengers in the front seat right through the car's windshield. Seat belts keep this from happening.

If you've ever been in a car that has stopped short you know how the force of a sudden stop causes your whole body to jerk forward. Even though the car has stopped, your body continues to travel forward at the same speed the car was traveling. The effect is much stronger when a moving car is involved in a collision with another car or a stationary object, such as a tree. No matter how strong you are, the force of a collision can knock you right out of your seat.

Seat Belt Smarts

Seat belts protect drivers and passengers by keeping them in their seats and preventing them from falling forward. On impact, the seat belt mechanism locks to keep you strapped firmly in place. If a car is hit from the side, the force of the impact might cause the driver to slide across the front seat and lose control of the car. Seat belts keep drivers in the driver's seat.

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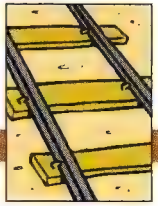
Are highways perfectly flat?



LAND TRANSPORTATION

1. Yes, the road surface is perfectly flat.
2. No, the road surface is slightly curved.

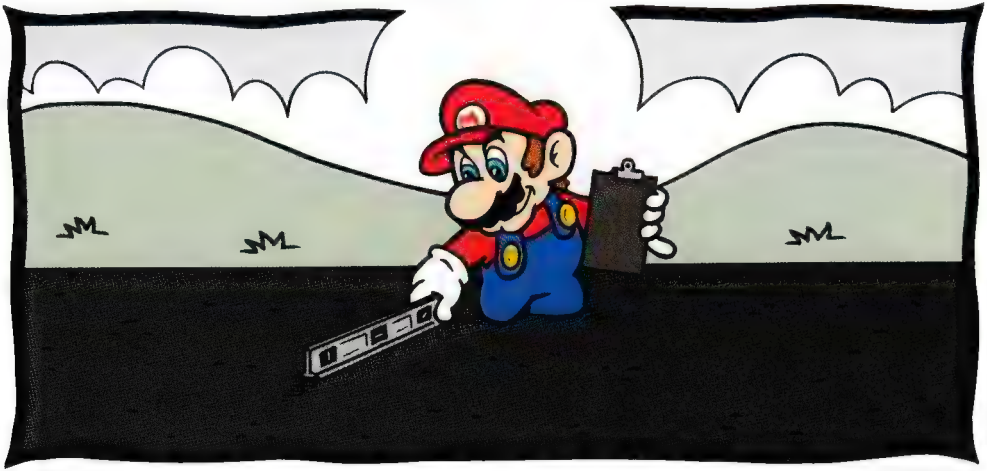


Illustration: Gary Fields

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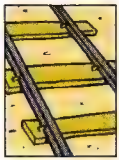
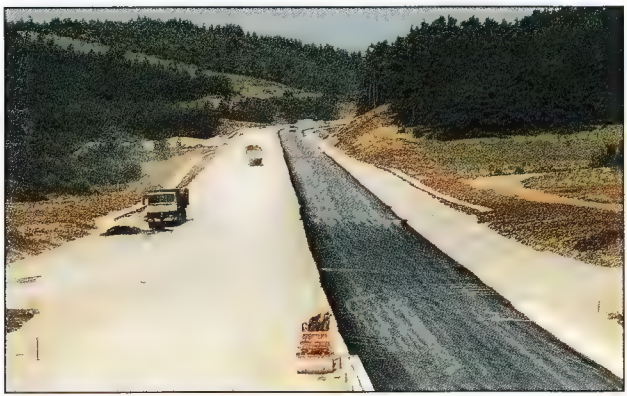
Road Construction

The surface of a highway is slightly higher in the center than at the sides. This allows rainwater and melting snow to run off into drainage ditches along the roadside.

2 The surface of highways is slightly curved.





© Jalain F. / Explorer

Heavy rollers compact the soil beneath a roadway before pavement is laid down on top of it.

Before a road is built, highway engineers conduct studies to determine how much traffic the road will carry, now and in the future. For example, if a new shopping center will be constructed nearby, traffic flow will increase substantially and the road must be built to accommodate it.

Construction Zone

After the new road's path is cleared of trees and boulders, the ground is compacted, or pressed down, with heavy rollers. This makes it firm enough to bear the weight of the pavement and the traffic without crumbling. Most roads are paved with asphalt, a substance that comes from petroleum. Because asphalt is flexible, it bears the weight of traffic and withstands temperature changes without cracking. On roads with little traffic, asphalt may be sprayed on in a thin layer. The heavier the traffic flow, the thicker the asphalt must be.

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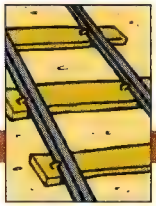
What substance is usually used to line tunnels?



LAND TRANSPORTATION

1. Aluminum
2. Concrete
3. Wood

Illustration: Gary Fields

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Tunnel

Can't go over or around a mountain? Dig a tunnel and go through it!

2 Most modern tunnels are lined with concrete.

© Len Sirman

During construction, roof supports are built inside a tunnel to keep it from collapsing and to give workers access to the roof.

Building tunnels for trains or automobile traffic takes a lot of work. Long before digging begins, engineers and geologists drill small sampling holes to extract samples of rock or earth from the proposed tunnel site. The samples reveal the characteristics of the different rock layers they will encounter as they dig, so they know what equipment and techniques they'll need to finish the job.

Having a Blast

Tunneling through mountains means breaking through layer after layer of rock. Carefully placed explosive charges are used to blast the rock into smaller pieces, which are loaded onto conveyers that carry them out of the tunnel. As digging progresses, roof supports are built inside the tunnel to stabilize it and keep it from collapsing. When digging is completed, the tunnel is lined with a layer of concrete, which helps the tunnel keep its shape even if the rocks surrounding it shift.

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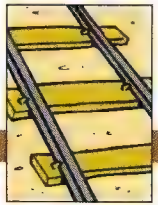
What does a car's suspension do?



LAND TRANSPORTATION

1. Protects its body from rust
2. Helps it ride smoothly over bumpy roads
3. Connects the steering column to the axle

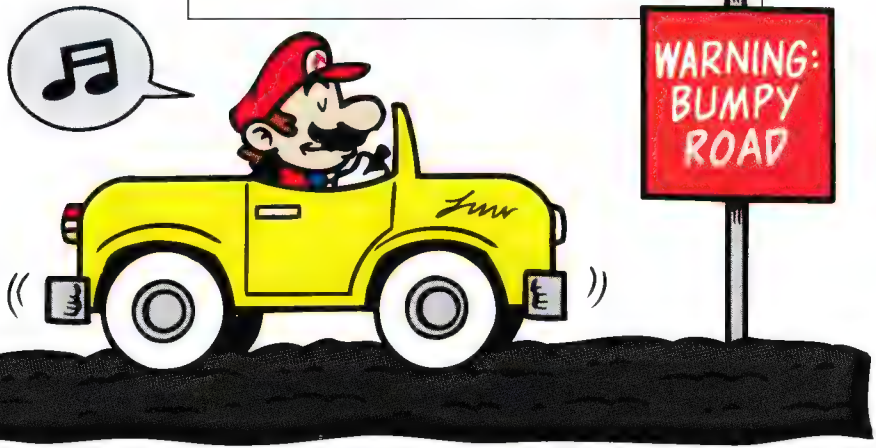


Illustration: Gary Fields

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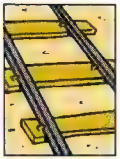
Car Suspension

A car's suspension holds the car body over the wheel axles. It prevents the car body from absorbing the full impact of bumps in the road.

2 A car's suspension helps it ride smoothly over bumpy roads.



© D. Freppel / Fotogram Stone

Off-road vehicles, like Jeeps, have heavy-duty suspension systems that absorb all the bumps of rugged terrain.

When a car hits a bump in the road, its wheels bounce up and down but the car body doesn't. This is because the car body is suspended above the wheels on springs and shock absorbers. The suspension gives passengers a smooth ride, even on bumpy roads.

Springs and Shocks

Today most car suspension systems use coil springs. Older cars frequently had two types of springs. Attached to the axle inside each front wheel was a heavy-duty coil spring. Behind each rear wheel was a different type of spring, called a leaf spring. It looks like a stack of narrow metal bars with cushions of air between them. The car's shock absorbers keep the car from bouncing all the time. The shock absorbers control the impact of a bump so that the car bounces once and then stops bouncing. Without shock absorbers, a car could hit a bump and then continue boinging down the road for miles!

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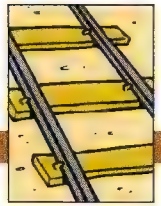
Which part of a car's engine causes the wheels to turn?



LAND TRANSPORTATION

1. Carburetor
2. Crankshaft
3. Shock absorber

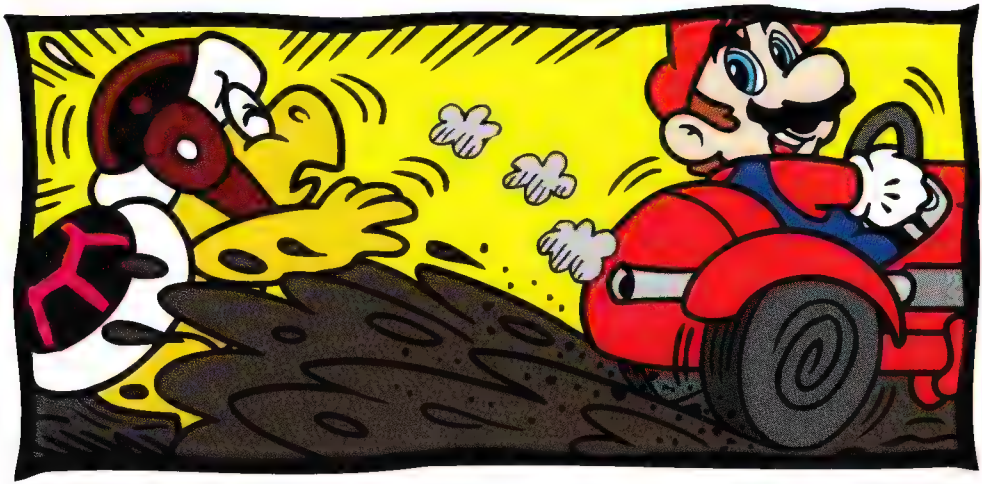


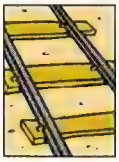
Illustration: Gary Fields

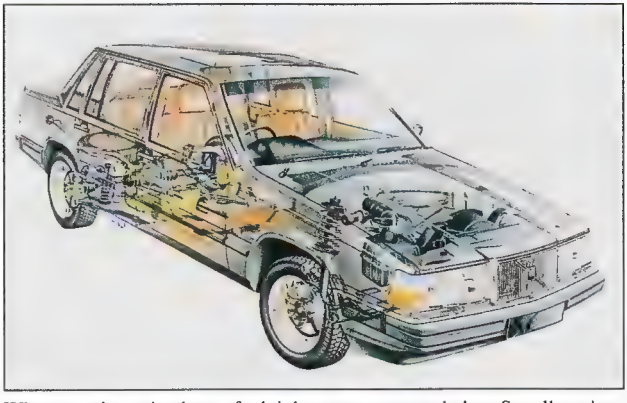
©1996 Nintendo

Car Engine

Inside an automobile engine, gasoline is combined with oxygen and ignited, or set on fire, to produce a controlled explosion. This explosion provides the energy that powers the car.

2 The crankshaft causes the wheels to turn.





© Len Sirman

When a car's engine burns fuel, it becomes extremely hot. So, all engines are equipped with cooling systems that use air and water to keep the engine from burning out.

When a driver presses on the gas pedal of a car it causes the fuel pump to feed gasoline into the car's engine. The fuel travels through tubes or lines from the gas tank to the fuel injection system which sprays it directly into the engine where it mixes with air.

As the fuel flows into the engine, it passes the spark plugs. The spark plugs create the spark that ignites the fuel. As the fuel burns, it powers the engine.

Driving Force

The heat produced by the burning fuel creates hot air and gases which make the car's pistons move up and down. The pistons are attached to the car's crankshaft; as they move up and down they cause the crankshaft to turn. The crankshaft is connected to the car's axles. When the crankshaft turns, it cause the axles to turn. The axles make the car's wheels turn.

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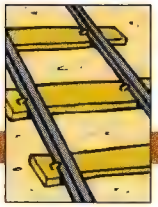
What gives a car its electrical charge?



LAND TRANSPORTATION

1. Battery
2. Carburetor
3. Headlights

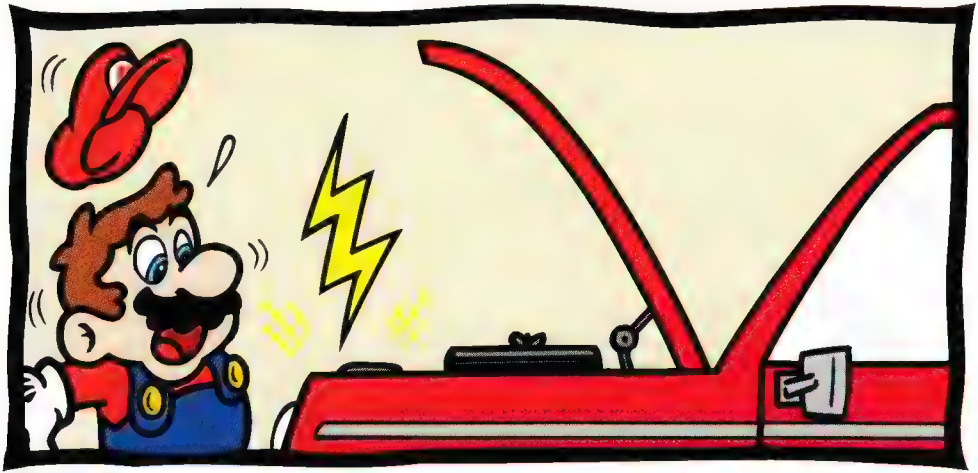


Illustration Gary Fields

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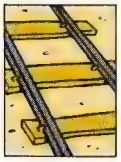
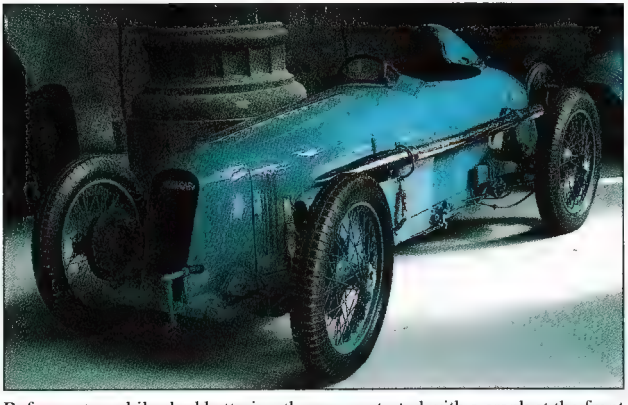
Car Battery

The battery provides the electrical charge needed to start a car's motor. It also powers the radio, headlights, and other necessary accessories.

1 A car's battery provides its electrical charge.





© B. Regent / DIAF

Before automobiles had batteries, they were started with a crank at the front of the car. One or two turns of the crank were usually enough to create the spark that started the engine.

Turning a key to start a car engages the car's ignition system. It's called the ignition because it creates a spark that ignites, or sets fire to, the fuel which the car uses for power. The car's battery provides the electrical charge that creates the spark.

Battery Powered

In most cars, the battery is positioned under the hood near the front. It looks like a rectangular box with two pegs, called terminals, coming out of the top. Inside the battery are sets of flat plates made of lead and lead oxide floating in sulfuric acid. Since the acid is harsh, and can burn skin and corrode metal, the battery is tightly sealed so the acid doesn't escape.

When the ignition key is turned, the battery generates the electricity needed to create the spark that starts the engine. Once the car has been started, the engine's alternator feeds current back into the battery to recharge it.

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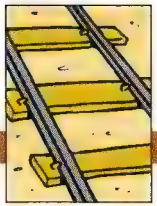
What causes a car to hydroplane?



LAND TRANSPORTATION

1. Fouled spark plugs
2. Missing jumper cables
3. Wet road surfaces

Illustration: Gary Fields

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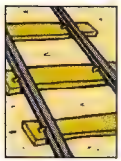
Hydroplaning

When a car hydroplanes, its tires can't grip the road surface. The car floats or skids across water that collects on a wet road surface.

3 A car will hydroplane on wet road surfaces.



© Ph. Chardon / Option Photo

The hydroplaning effect, in which a car's tires lose contact with a wet road surface, was first discovered and described by scientists at NASA.

Oil-based asphalt paving material keeps a road from absorbing rainwater. During a heavy rainstorm, rainwater collects on top of the road surface. When a car drives across these sheets of water at high speed, its tires lose contact with the road surface and rest on top of the water. This is called hydroplaning.

Dangerous Driving

Hydroplaning is dangerous because when the car's tires lose contact with the road surface, the driver loses control of the car. The car may skid out of its lane or even off the road. To avoid hydroplaning, drivers reduce their speed when driving in heavy rain. Generally, hydroplaning doesn't occur at speeds under 35 miles per hour (56 km/h). Drivers can also travel in the exact paths of the cars before them. These paths, sometimes called "tire wipes," are slightly drier than the rest of the road surface.

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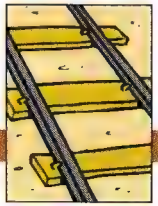
How long did it take to carry mail across the U.S. in 1863?



LAND TRANSPORTATION

1. Two Months
2. One Month
3. One Week

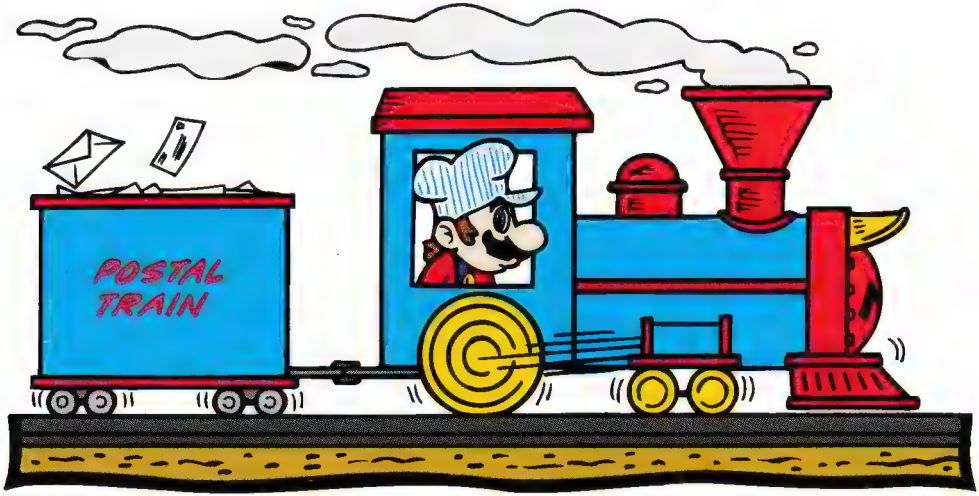


Illustration: Gary Fields

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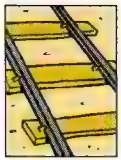
Postal Trains

When the Railway Mail Service started, it took a week to carry mail from New York to San Francisco.

3 It took one week to carry mail across the U.S. in 1863.



© Harlingue-Viollet

Inside a railway postal car, clerks sorted the mail as the train sped across the country.

When the United States was a mere 13 colonies on the eastern shore, transporting mail from place to place was relatively easy. Once settlers moved westward, mail distribution became more difficult.

At the beginning of the 19th century, it could take weeks for a letter to travel across the country. Coaches that carried mail cross-country could make it in just over two weeks. The Pony Express, which started in the early 1860s, used individual riders who could sometimes travel faster than coaches did.

All Aboard

With special postal trains, the Railway Mail Service was able to speed cross-country mail delivery. Clerks in the postal cars started a trip with huge bags of unsorted mail. As the train traveled, they sorted the mail, dropped it off at stops along the way and picked up more mail. By 1889, they had cut the mail delivery time to five days from coast to coast.

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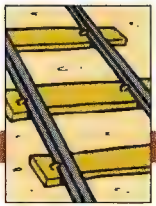
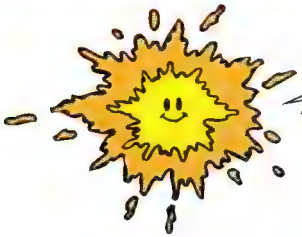
When were corridors added to passenger train cars?



LAND TRANSPORTATION



1. About 1790
2. About 1850
3. About 1930

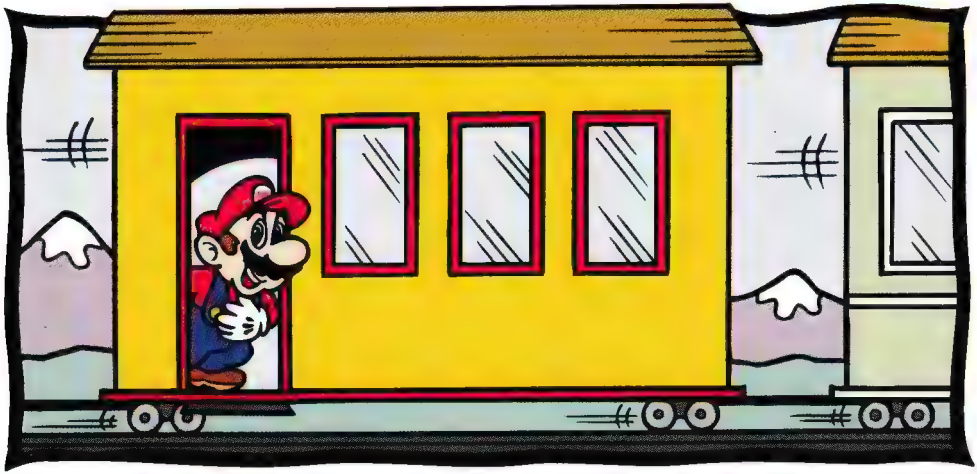


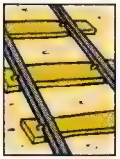
Illustration: Gary Fields

©1996 Nintendo

Passenger Trains

The first trains were built to haul freight, not to carry passengers. People who wanted to ride the rails sometimes sat in the coal car!

2 Passenger trains were equipped with corridors about 1850.



© Soazig / Explorer

Before trains had corridors that connected compartments on the inside, passengers boarded the train through doors that gave access to compartments only from the outside.

Pretty soon it became clear that railroads could make a lot of money transporting passengers as well as freight. The first passenger railway cars were not much more than stagecoaches fitted with wheels that would roll on the rails. Coaches for first class passengers had roofs, glass windows, and padded seats. Second-class cars were covered by a canopy and were open on the sides. Third-class cars had no roof, and passengers sat either on wooden benches or on the floor.

Public Space

Later trains were made up of individual compartments that held about six people each. The compartments could only be entered from doors on the outside of the train. In the 1850s, trains were designed with corridors that connected the compartments inside the train, and that connected the cars to each other.

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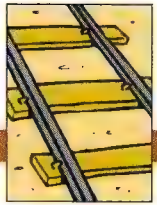
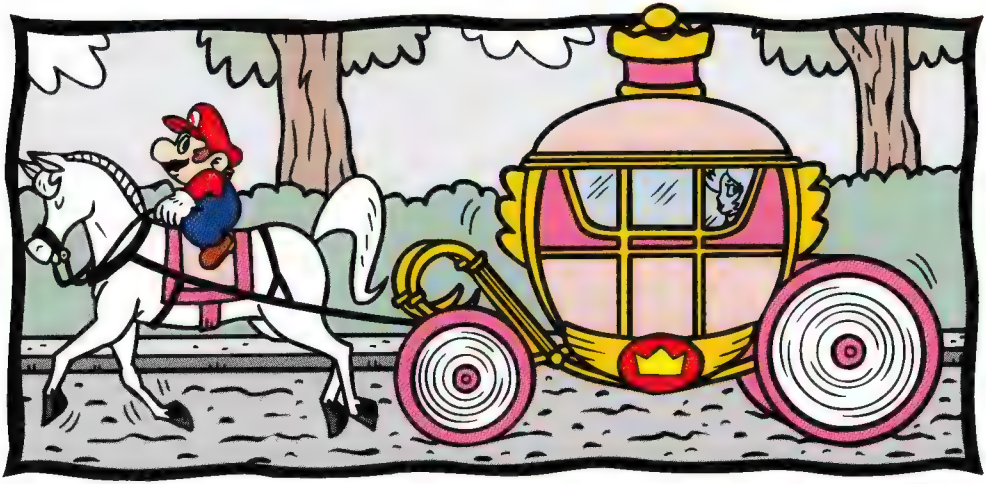
When were the first horse-drawn carriages used?



LAND TRANSPORTATION

1. 15th century
2. 16th century
3. 17th century



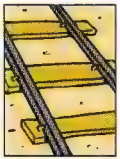
Illustration, Gary Fields

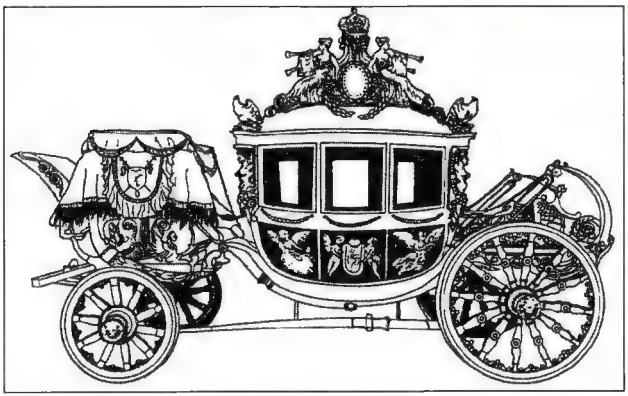
©1996 Nintendo

Carriages

Horse-drawn carriages evolved from the chariots of ancient times. The first carriages were probably made in Hungary.

1 **The first horse-drawn carriages were used in the 15th century.**





© D.R.

Before the age of the automobile, people traveled in horse-drawn carriages.

Word of the convenient vehicles soon spread around Europe. Eventually certain horses were bred specifically as coach horses.

Carriages weren't just a means of transportation. They also became a way for people to show off to their neighbors. Wealthy people commissioned carriages trimmed with gold or painted with elaborate decorations, and they employed drivers to drive them around.

Carriage for Hire

It wasn't always practical for people who lived in cities to own carriages. Having a carriage meant they had to have a place to store it and a stable to house the horses. Instead, people in cities relied on hackney coaches to take them from place to place. Hackneys, named for a town outside London, England, were the forerunners of today's taxis. In fact, "hack," which comes from hackney, is a slang expression for a taxi.

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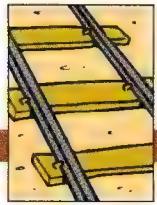
Which car manufacturer produced the Beetle?



LAND TRANSPORTATION

1. Honda
2. Oldsmobile
3. Volkswagen

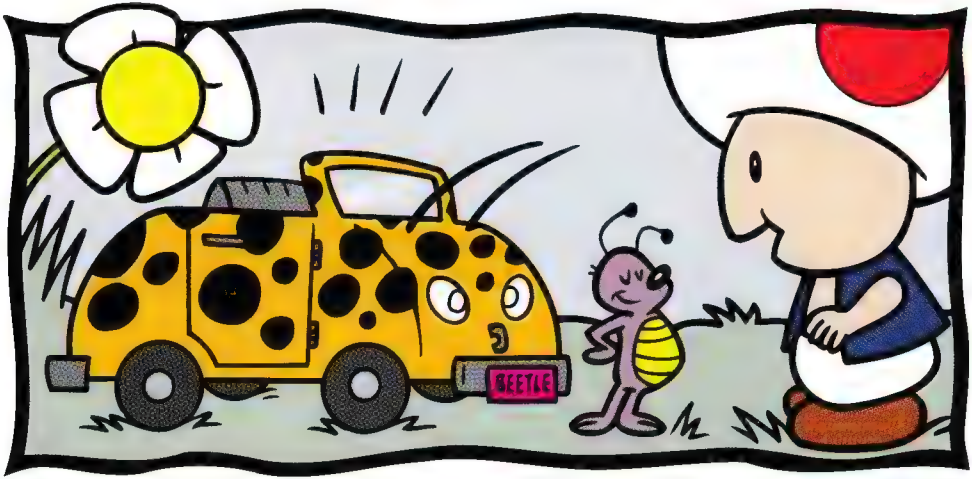


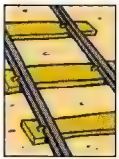
Illustration: Gary Fields

©1997 Nintendo

Volkswagen

One of the more unusual features of the Volkswagen Beetle was its trunk—it was in the front! The engine was at the back of the car.

3 Volkswagen produced the Beetle.



© N Quidu / Gamma

By the time Volkswagen stopped making the Beetle in 1978, it had become the best-selling car in automotive history.

In German, Volkswagen means "people's car." Engineer Ferdinand Porsche (known for his high performance sports cars) created the Volkswagen to be a reliable car that an average family could afford. The company was founded in 1937, supported by the German government. When Germany entered World War II in 1939, Volkswagen factories were used by the military. They didn't make civilian cars again until the late 1940s.

Learning From Ford

To cut manufacturing costs, Volkswagen followed the business strategy of U.S. auto maker Henry Ford and concentrated on only one style of car: the Beetle. Models barely changed from year to year. Because Volkswagen had been Adolf Hitler's pet project, many countries (including the U.S.) wouldn't buy them at first. VWs didn't become popular outside Germany until the 1960s.

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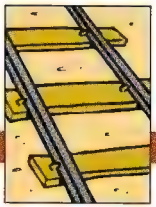
When were the first motorized buses used?



LAND TRANSPORTATION

1. 1760
2. 1830
3. 1920

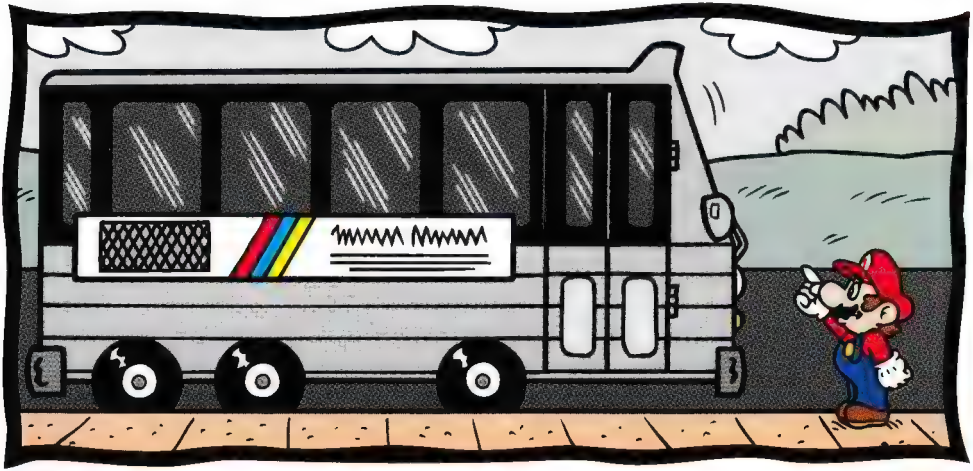


Illustration: Gary Fields

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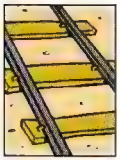
Bus

The word "bus" comes from *omnibus*, a Latin word meaning "for all." Before there were motorized buses, there were large horse-drawn carriages called omnibuses.

2 The first motorized bus was used in 1830.



© Len Sirman

In some European cities, buses are extra-long. The flexible section in the center bends to allow the bus to turn corners more easily.

Buses are a form of mass transportation—vehicles used to carry many people at one time. Mass transportation is especially important in cities where lots of people are on the move all the time. If every person in a city drove his or her own car, the streets would be so blocked with traffic that no one could go anywhere! With mass transportation, many people travel in one vehicle so the streets are less crowded with traffic.

The Wheels on the Bus

The first motorized bus was used in England. It carried 18 passengers from London to the city of Bath. It traveled slowly, but people liked the convenience. Soon England had the world's first regularly scheduled bus service. As engine technology improved, so did bus design. By 1903, in Germany, there were comfortable buses for city and country routes.

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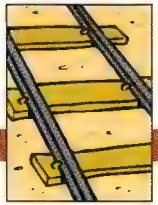
What type of vehicle uses derailleur gears?



LAND TRANSPORTATION

1. Automobile
2. Bicycle
3. Train

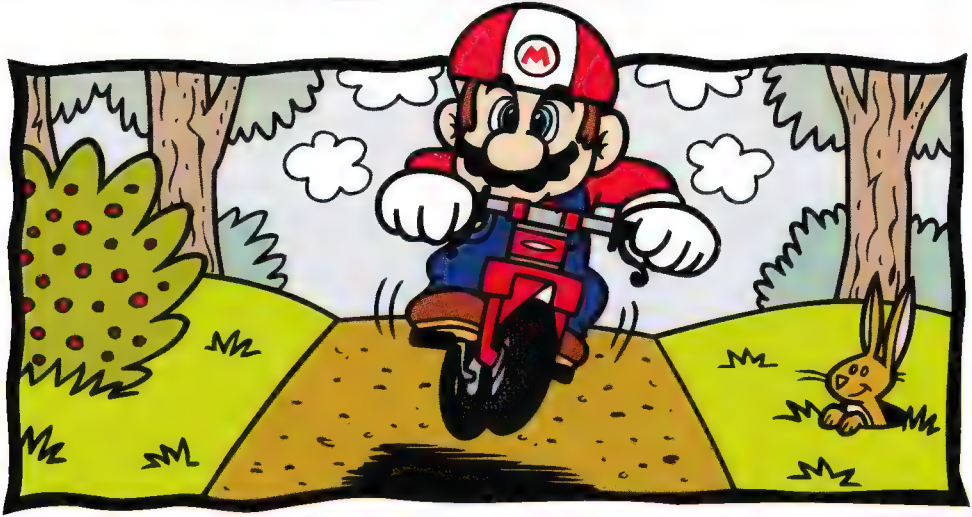


Illustration Gary Fields

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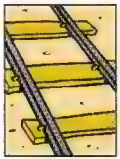
Derailleurs

Bicyclists shift gears so they can pedal at a steady, efficient rate on all terrains. Before the invention of derailleurs, a cyclist had to remove the rear wheel, turn it around, and reassemble the bike to shift gears.

2 A bicycle uses derailleur gears.



© F. Stock / Sunset

Shifting gears makes it easier for cyclists to pedal when they're riding uphill.

Derailleurs let a cyclist shift gears while he or she is riding. Shifting gears is useful for cyclists, especially bicycle racers, because it lets the rider adjust the tension on the pedals according to terrain and his or her abilities.

Getting in Gear

Some riders have powerful legs, but they can't move quickly. Others are able to pedal fast, but they can't push hard on the pedals. Shifting gears lets every rider pedal to maximum efficiency. In some gears, a rider pedals a lot but needs minimal pressure to pedal. Other gears require a lot of pressure, but less frequent pedaling.

Name Game

Derailleurs are controlled by levers located on the bike frame or handlebars. Shifting the levers moves, or "derails," the bike chain to different sprockets on the wheels. This is how derailleurs got their name.

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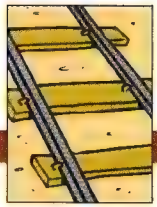
Why should kids wear bike helmets when they ride?



LAND TRANSPORTATION

1. To protect them from injury
2. To help them see better
3. To help them ride faster

Illustration, Gary Fields

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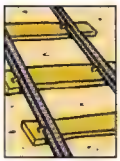
Bike Helmets

Several U.S. states have laws requiring kids to wear helmets when they ride their bikes. Adults should wear bike helmets when they ride, too.

1 Bicycle helmets protect riders from injury.



© L. Maquet

What's wrong with this picture? This boy should be wearing a bike helmet!

You never know when you might fall off your bike. Even experienced riders can hit a bump or a slippery patch on the road that sends them flying. Sometimes a fall from a bike leaves you with a few scrapes and bruises, but often the injuries are far more serious.

Heads Up

The Centers for Disease Control, a U.S. government agency, conducted a study that found that each year more than 135,000 kids suffered head injuries from falling off their bikes. That's a lot more than the total number of kids in your grade at school. Head injuries are serious. They can leave you paralyzed; they even can kill you. Wearing a bike helmet reduces the risk of head injuries. If you fall and bump your head, the outer shell of the helmet absorbs the force of the blow and the padding inside the helmet cushions your head. This is why many states require bike riders to wear helmets.

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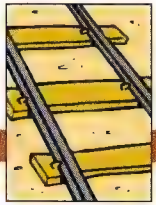
Who built the first car with an internal combustion engine?



LAND TRANSPORTATION

1. Karl Benz
2. Henry Ford
3. Milton Hershey

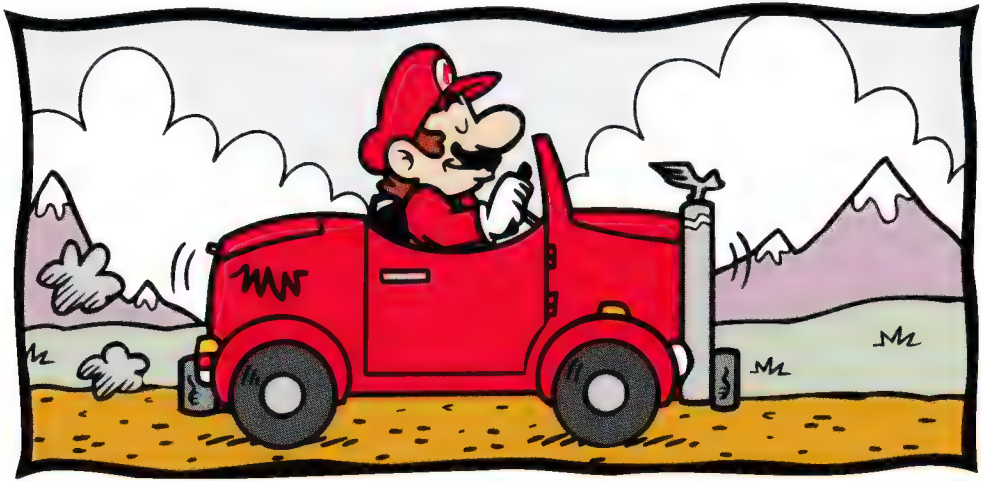


Illustration: Gary Fields

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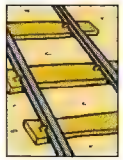
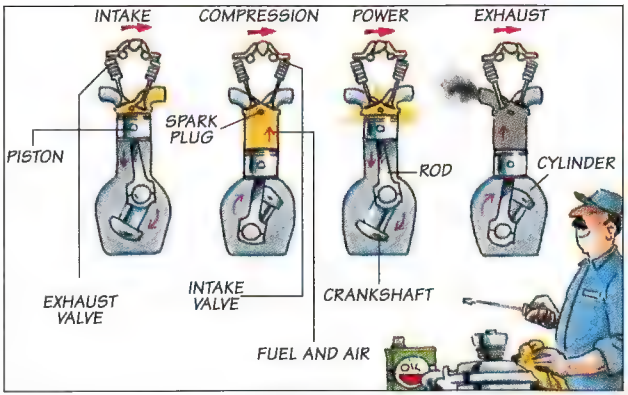
Combustion Engine

German engineer Karl Benz used an internal combustion engine to power a three-wheeled car in 1886. The car reached a speed of 8 miles per hour (13 km/h).



1 Karl Benz built the first car with an internal combustion engine.



The four parts of the four-stroke cycle are Intake, Compression, Power and Exhaust.

An internal combustion engine burns fuel inside the engine chamber. External combustion engines, such as steam engines, burn fuel outside the engine.

Four Strokes

Small internal combustion engines, like those in motorcycles, work on a two-stroke cycle. Car engines use a four-stroke cycle. The strokes are the up or down movements of the piston.

In the first stroke, the piston moves down, opening an intake valve and shutting an exhaust valve. This lets fuel and air enter the engine chamber. In the second stroke, the piston moves up and compresses the fuel and air mixture. In the third stroke, the piston moves down and a spark ignites the fuel mixture. In the fourth stroke, the exhaust valve opens to let fumes escape from the chamber.

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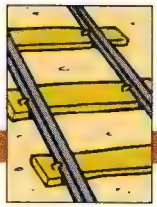
What is a cog railway primarily used for?



LAND TRANSPORTATION

1. Hauling freight
2. Traveling across continents
3. Traveling uphill

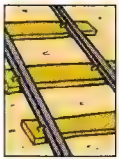
Illustration: Gary Fields

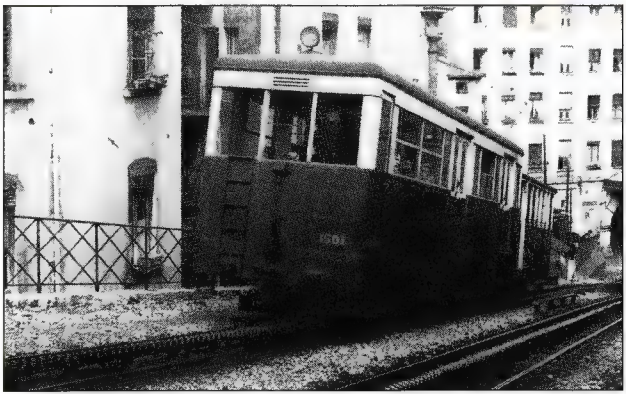
©1997 Nintendo

Cog Railway

The first cog, or rack, railway was built to travel up Mount Washington in New Hampshire in 1869. Another cog railway runs up Pikes Peak in Colorado.

3 A cog railway is used for traveling uphill.





© Paillard / La Vie du Rail

Cog railways, like this one in France, are used in the Alps of Europe and the Andes Mountains of South America.

Ordinary trains use friction between the wheels and the rails to hold them to the track. This is fine when the train is traveling on flat ground or up a slight incline, but when a train must climb a steep hill, friction isn't strong enough to counter the gravitational force pulling the train back down the hill.

Uphill Battle

For trains that climb steep hills, a cog or rack rail system is used. The track is equipped with a central rack rail which meshes with a cog wheel attached to the bottom of the train. As the cog wheel turns, it grips the rack rail and pulls the train up the hill. On the way down, the cog wheel grips the rail to prevent the train from careening down the slope.

Ordinary trains can climb hills with slopes, or grades, of 4 to 6 percent. A cog railway can climb hills with 38 percent grades.

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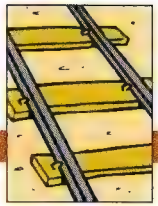
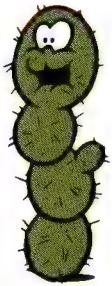
What is a viaduct?



LAND TRANSPORTATION



1. A plane that lands on water
2. A type of bridge
3. A mechanism for converting trains to diesel power

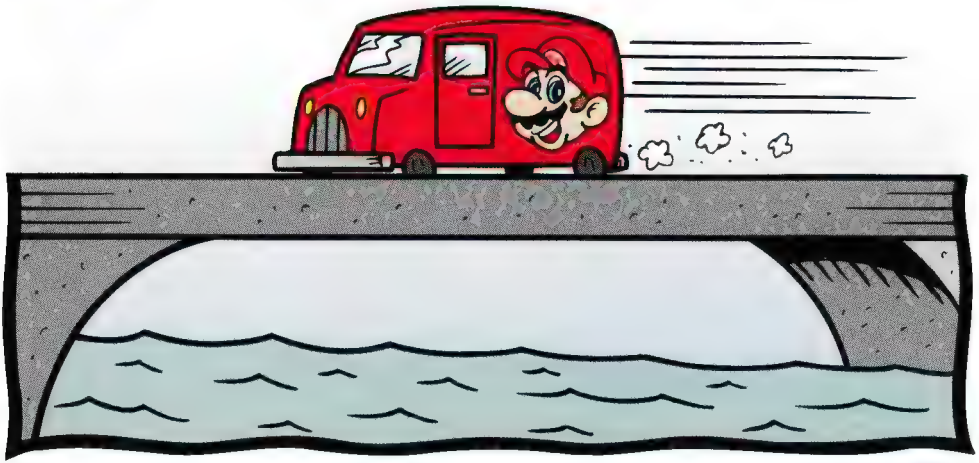


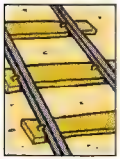
Illustration: Gary Fields

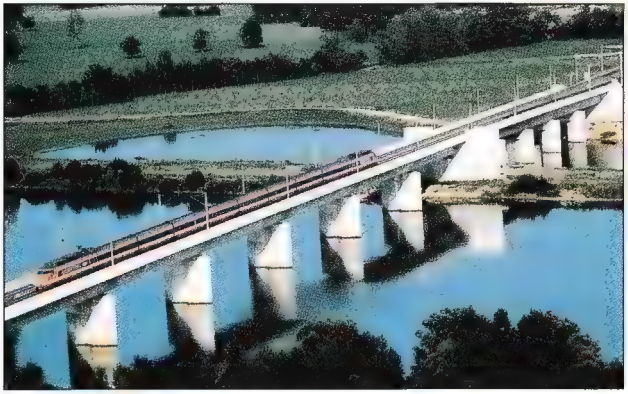
©1997 Nintendo

Viaduct

A viaduct is a type of bridge designed to carry cars or trains over water, a valley, or another road.

2 A viaduct is a type of bridge.





© Pilloux / La Vie du Rail

A viaduct is a long bridge supported by a series of pillars or arches.

You can recognize a viaduct by its structural style. Viaducts are usually long spans that are supported by a series of arches or pillars. The design dates back to ancient Rome, where the first viaducts were built to allow vehicles to cross rivers safely. The first Roman viaducts were low stone structures. Later on, they were built in layers of arches.

Under Construction

Over the years, viaducts have been made from a variety of materials. In the 18th century, they were constructed of iron. In the 19th century, steel was used, and some engineers built viaducts from timber. In the 20th century, steel reinforced concrete is used to build viaducts.

Among viaducts in the U.S. is the Tunkhannock Viaduct which carries the Erie-Lackawanna Railroad in Pennsylvania. The Pulaski Skyway, in New Jersey, is a viaduct for automobiles.

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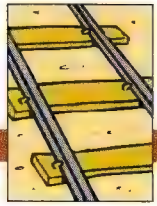
What is a car's chassis?



LAND TRANSPORTATION

1. Another name for the trunk
2. An attachment used for towing other vehicles
3. The underbody

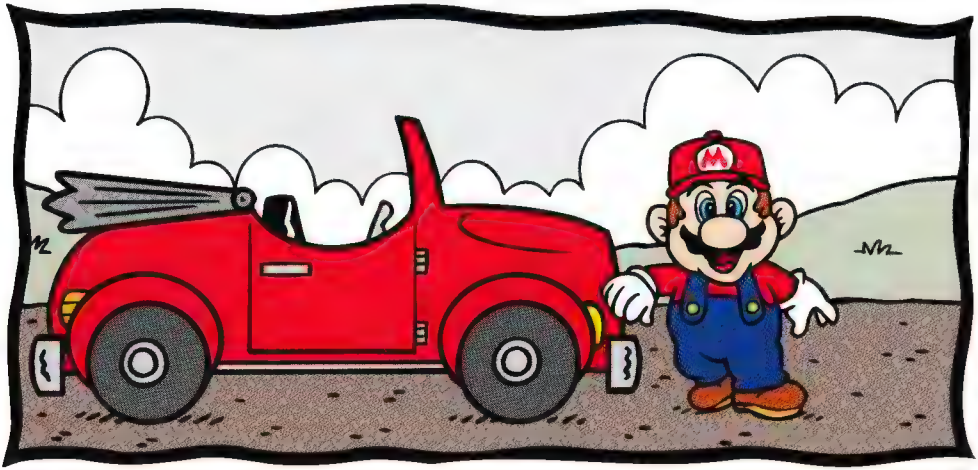


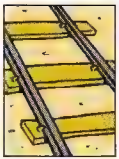
Illustration: Gary Fields

©1997 Nintendo

Chassis

The chassis of an automobile is generally defined as the underbody—a rectangular frame which supports the car's mechanisms.

3 A car's chassis is its underbody.



© Transglobe / Jernican

The chassis of a car is the underbody to which the frame and other parts are attached.

The chassis's purpose is to hold the car's body and engine and to provide a strong base to support the car's frame and all its parts. It must be strong and sturdy enough to resist severe bending or cracking, even on impact.

Connection

The chassis connects the car's frame or body to the axles and wheels below. In some small cars, the chassis and frame are constructed as one piece. Larger, heavier cars usually have separate frame and chassis construction.

Many automobile manufacturers mark car chassis with identification numbers. The numbers indicate the make, model, and year of the car. They're useful to police because they can help to positively identify a car that has been stolen.

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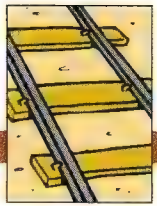
With what do we associate Rudolf Diesel?



LAND TRANSPORTATION

1. Automotive engines
2. Bicycle tires
3. Railroad tracks

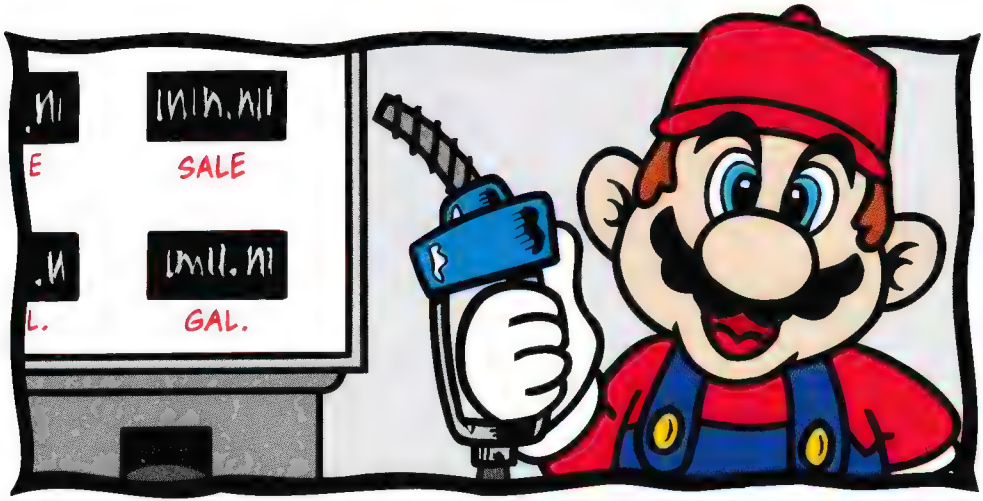


Illustration: Gary Fields

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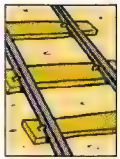
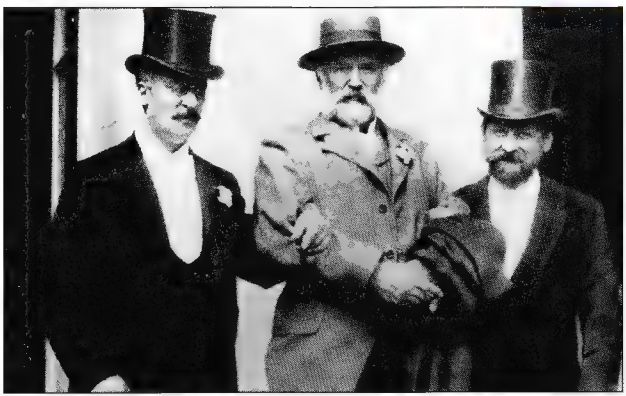
Diesel

German engineer Rudolf Diesel made a great contribution to automotive history with his design for an internal combustion engine.

1 Diesel is known for designing automotive engines.





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Rudolf Diesel, shown here on the left, was a celebrated engineer. He disappeared under mysterious circumstances in 1913, on a ferry trip from England to Belgium.

The diesel engine is similar to an ordinary gasoline engine, but it uses a heavier grade, or weight, of fuel. In both types of engines, the fuel has to be ignited so that it can burn to produce energy. The difference is in the way the fuel is ignited. A gasoline engine uses a device called a spark plug to create a spark that sets the fuel on fire.

Diesel engines don't have spark plugs. Instead, they work by spraying the diesel fuel onto the moving cylinders of the engine. The movement of the cylinder produces heat. It makes the air around it so hot that the fuel ignites without a spark.

Heavy Duty

Diesel engines are powerful, but they produce more noise and exhaust than gasoline engines. Though some cars have diesel engines, they're used mainly in heavy-duty vehicles such as train locomotives and trucks.

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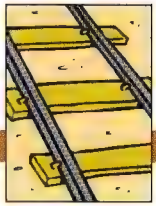
What is a TGV?



LAND TRANSPORTATION

1. High-speed train
2. Mass transit system in Albany, NY
3. Transcontinental ground vehicle

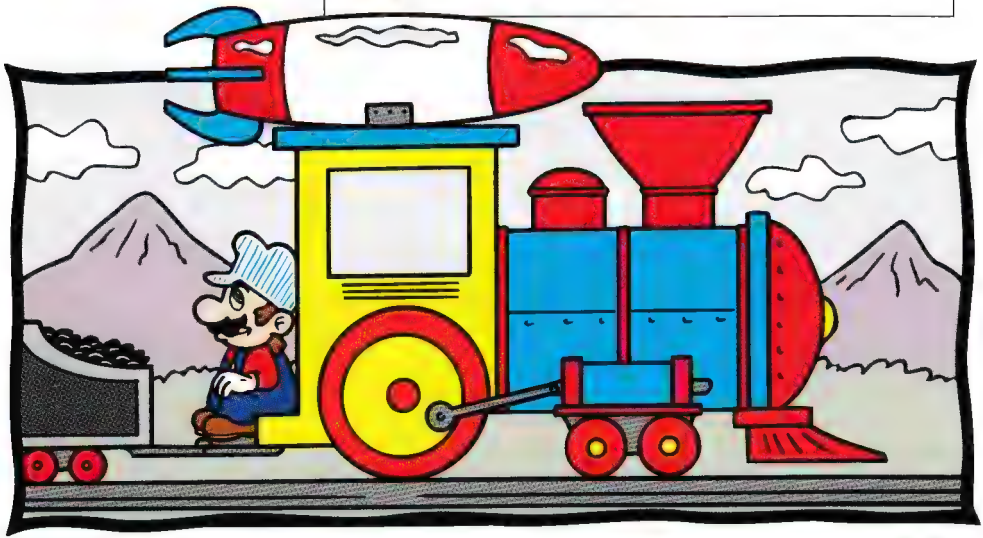


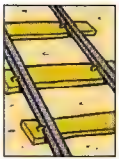
Illustration: Gary Fields

©1997 Nintendo

TGV

A TGV is a French train. Its initials stand for Train a Grande Vitesse, or "high-speed train." The first TGV trains were introduced in the 1970s.

1 A TGV is a high-speed train.



© Explorer

TGVs are electrically powered. Their bodies are sleek and smooth to reduce wind resistance.

TGVs are lightweight and sleek to reduce wind resistance. They consistently set records for high speeds. On an ordinary run, a TGV reaches speeds above 186 miles per hour (300 km/h). In a 1989 speed test, a TGV traveled 320 miles per hour (515 km/h)! To reach these high speeds, a TGV requires a special type of track. However, the trains also can run at ordinary speed on ordinary rail track. This made them economical to operate because it meant they could be introduced without the need for replacing every inch of track.

TGVs Around the World

Most TGVs operate in France. They also are in Belgium and Germany, and there are plans to bring TGVs to South Korea. Right now in the U.S., the Florida Department of Transportation is considering a plan to build TGV service between Miami and Orlando.

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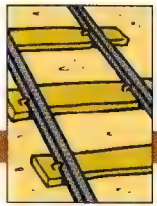
Which is used to carry passengers on a motorcycle?



LAND TRANSPORTATION

1. Side arm
2. Sidecar
3. Sidekick

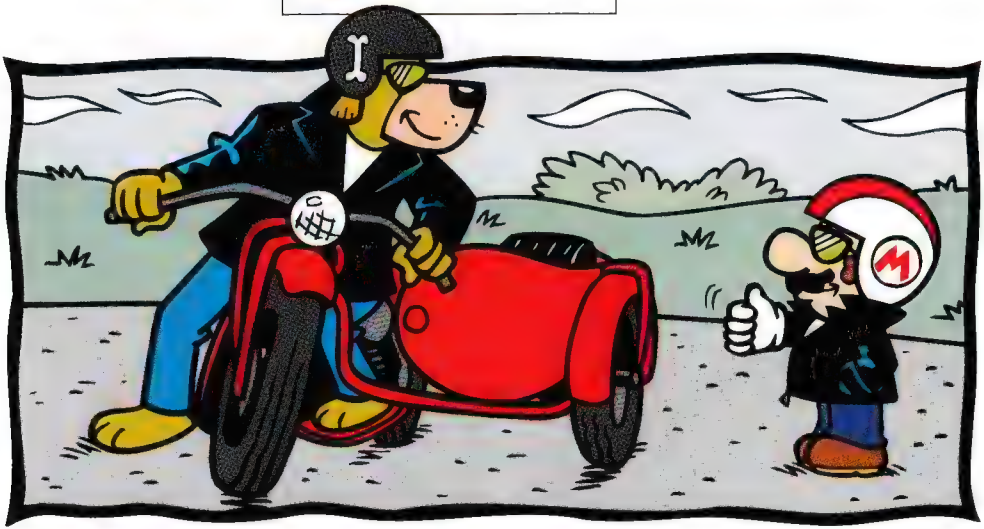


Illustration Gary Fields

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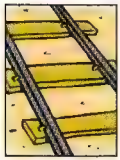
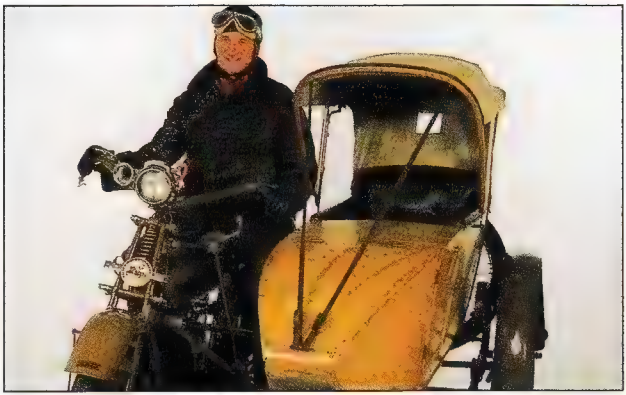
Sidecar

A sidecar is a one-wheeled cart attached to the side of a motorcycle. It's big enough to carry one passenger.

2 **A sidecar is used to carry passengers on a motorcycle.**





© Len Sirman

This vintage motorcycle is equipped with a sidecar to hold a passenger. When the sidecar is empty, a motorcyclist usually weights it down with sandbags to stabilize the vehicle.

Sidecars were commonly used on military motorcycles during World War II. Today, it's rare to see motorcycles fitted with sidecars, however these three-wheeled "bikes" are often used in motocross events.

Racing Team

Sidecar racing is popular all over the world—especially in Europe and Japan. Some racers compete in vintage bikes and others prefer races for ultramodern motorcycles with sidecars.

Motocross events are held on dirt tracks, with bumps, ruts, and hills. If it rains, the two-person racing teams compete in the mud!

Power Shifting

The person in the sidecar does more work than the motorcycle driver in a motocross event. Because the sidecar upsets the motorcycle's balance, the passenger must move his body around constantly to allow the team to accelerate without flipping over on turns and jumps.

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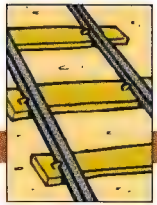
Where did Jaguar automobiles originate?



LAND TRANSPORTATION

1. England
2. Germany
3. United States

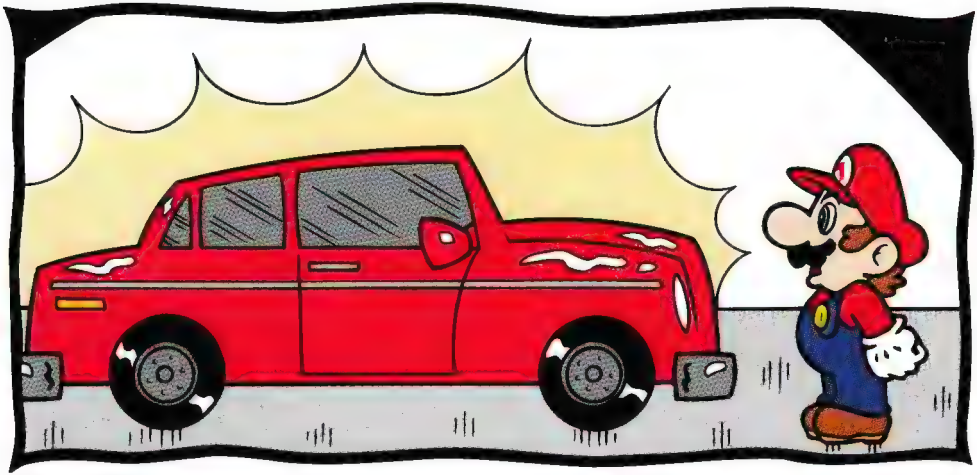


Illustration: Gary Fields

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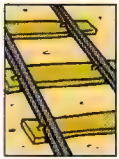
Jaguar

The first Jaguar was introduced in 1935. It offered artistic styling and high performance at a reasonable price.

1 Jaguar automobiles originated in England.



© Len Sirman

Jaguar automobiles, now produced by a division of the Ford Motor Company, are famous for their sleek lines and high performance engineering.

William Lyons, founder of Jaguar Cars Ltd., began his automotive career manufacturing motorcycle sidecars. He was just 21 when he and a friend borrowed money from their parents to start the Swallow Sidecar Company in 1922.

Introducing the Jaguar

After several years, Lyons branched out to design car bodies and eventually to create new cars. He had a dramatic design style, and his car bodies were sleek and beautiful. Since almost every car on the road was black, Lyons broke the mold with two-tone color schemes in colors like Nile Blue and Primrose Yellow. His early cars weren't even available in basic black!

He wasn't an engineer, so he hired the best engineers and technicians he could find to develop the new high-performance cars. Jaguars were among the first ordinary roadsters able to travel at 100 miles per hour (160 km/h).

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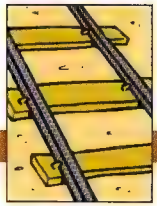
In which war were tanks first used?



LAND TRANSPORTATION

1. War of 1812
2. World War I
3. Korean War

Illustration: Gary Fields

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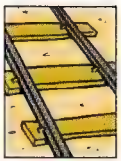
Tanks

The first armored vehicles, called tanks, were used in battle in 1916. The ride was so bumpy, the crew had to wear padded clothing to protect them!

2 Tanks were first used in World War I.



© P. Wysocki / Explorer

Modern tanks, such as this one, are equipped with guns that have a range of more than 4,375 yards (4,000 m).

William Tritton, an English engineer, built the first tanks for the English army in World War I. They were designed to roll across battlefields and destroy enemy artillery while protecting the troops inside. Though the idea made sense, the earliest tanks had limited use. The huge weight of the tanks carried on primitive caterpillar tracks made them almost impossible to move on the vast muddy battlefields. Steering took four men, and even under the best conditions the tanks could only reach a maximum speed of 3.7 miles per hour (6 km/h).

Redesign for a New War

By the time Germany invaded Poland in 1939—marking the start of World War II—German engineers had developed faster, more efficient tanks. These armored vehicles, known as panzers, were responsible for much of Germany's success in battle at the beginning of the war.

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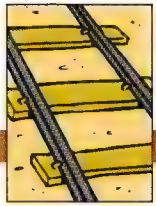
In which country do people drive on the left side of the road?



LAND TRANSPORTATION

1. Brazil
2. England
3. Switzerland

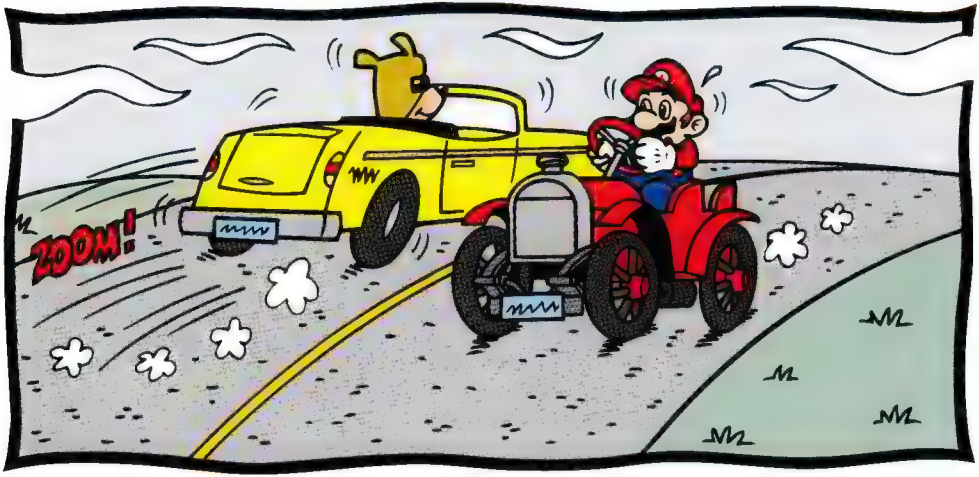


Illustration: Gary Fields

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Driving

In England, and most nations that are present and former English territories, people drive on the left side of the road.

2 People drive on the left in England.

© Len Surman

In most U.S. and Canadian cars, the driver sits on the left.

In almost every vehicle on the road in the United States and Canada, the driver sits on the left side. When cars travel, they keep to the right side of the road. This fundamental rule lets drivers know where their cars should be at all times. It keeps them from turning into oncoming traffic or creating hazards for other vehicles.

Right or Left

In England, Australia, India, Japan, and about 40 other countries, the rules are reversed. Cars are built with the driver's seat and steering wheel on the right. When they're on the road, drivers keep to the left.

Speedy Delivery

There's one common exception to the left-hand drive rule in the U.S. Local postal delivery trucks usually have right-hand driver's seats. This allows the driver to keep to the right side of the road—as traffic laws require—and still be able to reach into mailboxes at the side of the road to deliver the mail.

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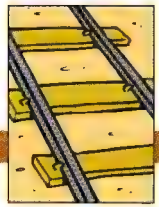
What does a car's odometer measure?



LAND TRANSPORTATION

1. Distance traveled
2. Engine temperature
3. Gas in the gas tank

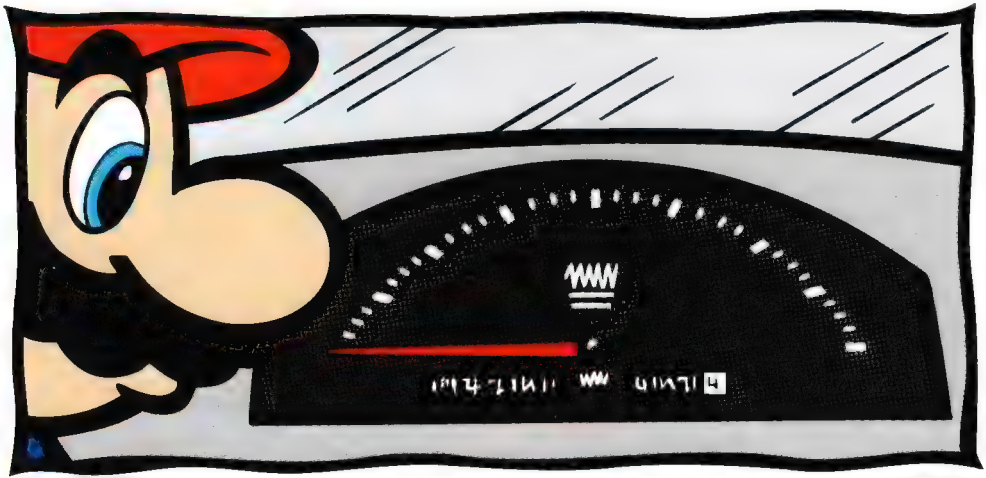


Illustration: Gary Fields

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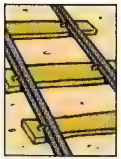
Dashboard

A car's dashboard is an information resource for the driver. It provides a constant status report on the car's performance and systems.

1 An odometer measures distance traveled.



© Len Sirman

A car's dashboard is a driver's information source.

A glance at the car's dashboard tells a driver how fast the car is traveling, how far it has traveled, and how much gas remains in the gas tank. Indicators on the dashboard also tell the driver when the signal lights or headlights are in use. Some dashboards even remind drivers to fasten their seatbelts and to make sure the car doors are closed.

How Fast? How Far?

The speedometer measures how fast the car is traveling. It is connected by a system of cables and gears to the car's drive shaft, which is connected to the wheels. As the wheels turn, the gears in the speedometer turn. The movement of the gears causes the needle on the speedometer to move as the car gains or loses speed.

The odometer is connected to the speedometer. It measures the revolution of the wheels and translates that into the distance the car has traveled.

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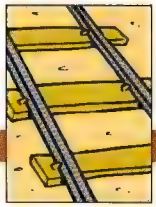
Where was the first cross-country rail connection completed?



LAND TRANSPORTATION

1. Chillicothe, Ohio
2. New York, New York
3. Promontory, Utah

Illustration: Gary Fields

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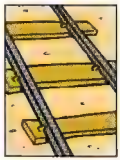
Railroad

The first transcontinental railroad connection in the United States was completed in 1869.

3 The first cross-country rail connection was completed in Promontory, Utah.



© Martinot / Stinset

The cross-country rail connection made in 1869 marked the start of enormous railroad development in the United States. Between 1870 and 1890, more than 100,000 miles (160,000 km) of track were laid.

Plans for rail service to carry passengers and freight from east coast to west coast were proposed in the 1840s. Construction didn't start officially until 1863, during the Civil War. The war slowed progress considerably.

Making Connections

In 1865, at the war's end, the railroads made up for lost time, virtually racing with each other to complete the line. The Central Pacific Railroad built eastward from San Francisco. The Union Pacific Railroad built westward from Omaha, Nebraska.

Golden Spike

On May 10, 1869, the two lines of track met in Promontory, Utah. Representatives from both rail companies celebrated the event by driving a golden spike into the tracks to complete the connection.

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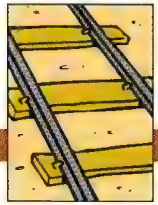
Which car system transmits power from the engine to the wheels?



LAND TRANSPORTATION

1. Brakes
2. Power Train
3. Suspension

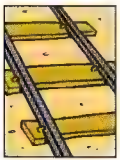
Illustration: Gary Fields

©1997 Nintendo

Power Train

A car's power train includes the transmission, clutch, drive shaft, and differential.

2 The power train transmits power from the engine to the wheels.



© M. Gimes / Sipa Press

Though front-wheel drive has become widespread only in recent years, the technology has existed since the 1930s. Some classic European cars, like this Citroën, were equipped with front-wheel drive.

In the past, cars were designed to send the engine's power to the rear wheels. This is known as rear-wheel drive. In effect, the rear wheels pushed the car forward. This was fine on dry, level surfaces, but it wasn't always effective in other conditions. Rear-wheel drive vehicles were prone to becoming stuck in mud and snow.

Move to the Front

The problem has been corrected with front-wheel drive cars in which the engine's power is transmitted to the front wheels. Front-wheel drive makes the car more stable because it places the weight of the car's engine—its heaviest part—over the wheels that drive the car. The added weight helps the car cut through snow and mud, and it helps the car grip the road in rain.

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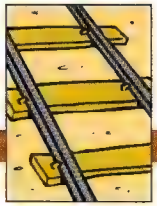
What powered the first automobile windshield wipers?



LAND TRANSPORTATION

1. Electricity
2. Steam
3. Humans

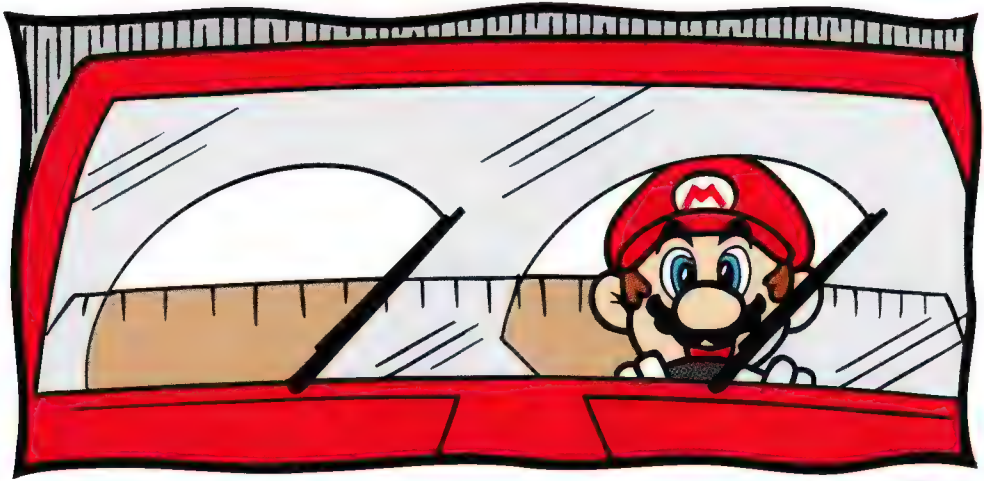


Illustration Gary Fields

©1997 Nintendo

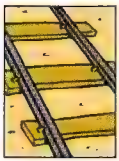
Windshield Wipers

The first windshield wiper was invented in 1903. It was hand-operated. Mechanical windshield wipers were introduced around 1916.

Some of these early windshield wipers were powered by compressed air from the car's engine.

Modern mechanical windshield wipers are powered by a car's electrical system. A rotating gear, called a worm gear, turns a crank that moves a rod to make the wiper blade move back and forth across the windshield. The wiper blades are made of rubber. They work like a squeegee to push the water from the windshield.

3 The first windshield wipers were operated by hand.



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For safety, drivers turn on their headlights any time they use their windshield wipers. When the weather is bad enough to require the use of windshield wipers, that means visibility is low. The lights make a car more visible to other drivers.

Wipe It Clean

Besides clearing rain and snow from the windshield, wipers can be used to clean the windshield. Most cars are equipped with receptacles that spray cleaning fluid at the windshield. The fluid, combined with the motion of the wipers, removes dirt and some ice from the windshield.

Because the rubber wiper blades can crumble or separate from the connecting rod, they must be replaced periodically.

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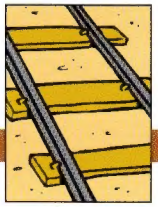
Who is responsible for the safety of passengers and freight on a train?



LAND TRANSPORTATION

1. Braker
2. Conductor
3. Engineer

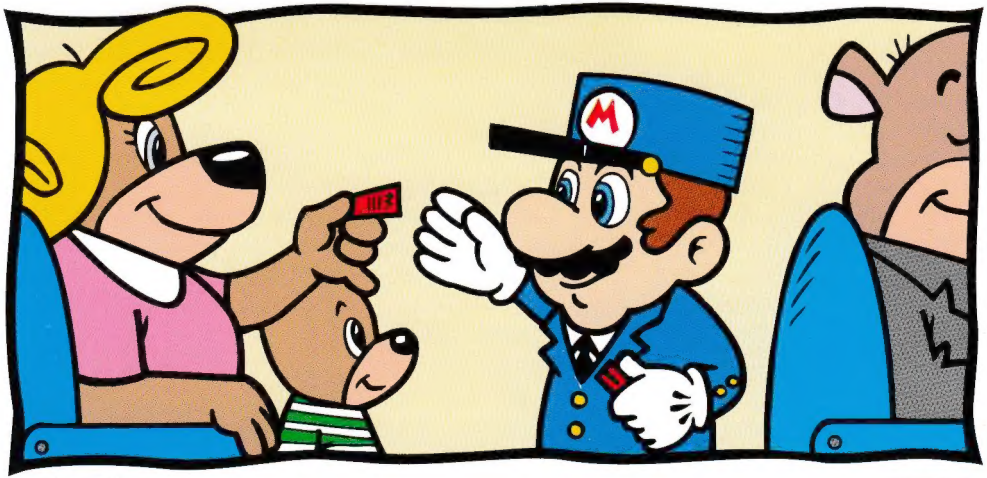


Illustration: Gary Fields

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Train Conductor

A train conductor's job involves more than merely punching your ticket. He or she makes sure the train follows the proper route and operates safely.

2 The conductor is responsible for safety of passengers and freight on a train.

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Have you boarded the correct train for your destination? Conductors check passenger tickets to be sure they get where they want to go.

Before a train leaves a terminal its conductor receives travel instructions from a dispatcher at the terminal. The conductor then passes this information on to the driver of the train. The instructions may direct the driver to skip certain stops or alert him to hazards along the route. It's up to the conductor to make sure that the instructions are followed.

Watch the Closing Doors

On the journey, the conductor collects passenger tickets and provides information for travelers. It's also the conductor's responsibility to make sure that passengers step aboard and leave the trains safely. Train drivers may not pull away from a station until the conductor gives the all clear signal, indicating that passengers and freight are safely away from the edge of the platform.

Conductors are also trained in emergency rescue skills such as CPR and fire safety.

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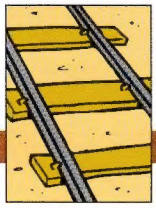
What's the difference between a freeway and a turnpike?



LAND TRANSPORTATION

1. Turnpikes are east of the Mississippi only.
2. Turnpikes have tolls; freeways don't.
3. Turnpikes run east-west; freeways run north-south.

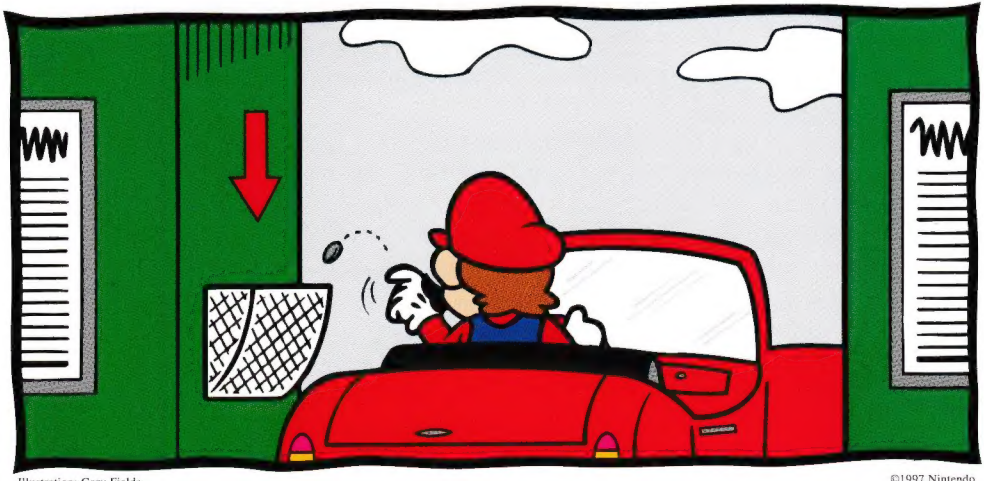


Illustration: Gary Fields

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Turnpikes

The Pennsylvania Turnpike, a toll road that originally ran from Harrisburg to Pittsburgh, Pennsylvania, is considered to be the first U.S. superhighway.

2 Turnpikes have tolls and freeways don't.

© Japack / Sunset

Tolls collected on United States highways are used for road maintenance.

Highways are major roads that are wide enough and generally straight and flat enough for high speed travel. They have a limited number of entrances and exits, and they're designed to provide fast, direct routes from city to city.

For example, the Massachusetts Turnpike, known locally as the "Mass Pike," runs east to west across the state, connecting the cities of Boston and Stockbridge.

What's in a Name?

A particular road may be known by different names in different places.

For example, Interstate Highway 5 extends all the way from San Diego, California, to Bellingham, Washington. At various points, it's known as the San Diego Freeway, Santa Ana Freeway, and Pacific Highway.

The designation "freeway" tells drivers that they will not have to pay tolls to travel the road. On turnpikes, drivers must stop periodically to pay tolls.

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